COAL CHEMICALS FOR WORLD MARKETS

By Joseph A. DeCarlo, Harry Perry, and Eugene T. Sheridan

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COAL CHEMICALS FOR WORLD MARKETS [1]

by

Joseph A. DeCarlo [2], Harry Perry [3], and Eugene T. Sheridan [4]

INTRODUCTION AND SUMMARY

The rapid growth of the organic chemical industry in the United States and abroad has focused attention on the future raw-material sources for this important industry. Chemical products are essential to modern civilization; and millions of tons of organic chemicals are used annually, ranging from basic raw materials to finished chemical products such as drugs, cosmetics, and soaps. Hundreds of chemical products are made directly or indirectly from coal, but in this report "coal chemicals" will be limited to crude tar, crude light oil, and ammonia recovered in the high-temperature carbonization of bituminous coal and the important principal products obtained by processing these materials. Specifically these include benzene, toluene, xylene, naphthalene, creosote oil, tar acid oil, pitch, and ammonium sulfate. Therefore the term "coal chemicals", wherever used in this report, includes only these products and does not include the secondary or intermediate products such as styrene, synthetic phenol, aniline, phthalic anhydride, or finished products made from these, such as synthetic rubber, plastics, and dyes.

The United States leads the world in production and consumption of coal chemicals. In the past five years nearly one-fourth of the total output of coal-tar crudes in the world was produced in the United States. Consumption of some of the more important products derived from these crudes such as benzene, toluene, xylene, and naphthalene, however, ranged from about one-third to one-half of the world total because of imports and production of benzene, toluene, and xylene from petroleum. The synthetic organic chemical industry of the United States was established during World War I on chemical raw materials obtained by the high-temperature carbonization of bituminous coal but this source of supply currently furnishes less than 40 percent. More than 60 percent of the chemical raw materials used to produce organic and inorganic chemicals is supplied by the petroleum industry and production of petrochemicals is rising rapidly.

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In Europe the petrochemical industry is in its infancy and the bulk of the raw materials used to make synthetic organic chemicals is obtained by carbonizing coal. For many years Germany has been one of the leading countries of the world in production of coal chemicals. Consequently this country has a well established coal-chemical industry and its light oil refining techniques are outstanding. Germany has developed a large export business in organic chemicals obtained largely from coal. The total value of chemical exports ranks next to machinery and a substantial proportion of this value is supplied by chemical products derived from coal. Great Britain is one of the foremost countries of the world in tar processing and currently produces a wide variety of tar products. In some of the western European countries such as France, Italy, and Belgium, however, supplies of refined coal chemicals are inadequate and a considerable quantity of these products are imported.

In the eastern countries progress in coal-chemicals production was slow until recent years. Since the end of World War II, however, tremendous strides have been made by some of these countries, particularly the U.S.S.R., and that country now ranks next to the United States in production of metallurgical coke and related products. In fact, the U.S.S.R. led the United States in metallurgical coke production in 1958 when the coke industry in the United States operated at only 64 percent of capacity.

In some European countries, particularly in eastern Europe, markets for the upgraded derivatives of crude light oil and tar have not been developed as yet and substantial quantities of benzene, naphthalene, creosote oil, cresols, pyridine, and other coal chemicals are exported to other countries. In recent years a large proportion of these coal chemicals was exported to the United States. Since 1955 about 15 percent of the benzene consumed in the chemical industry of the United States was imported, 20 percent of the naphthalene, 15 percent of the cresols and cresylic acid, and 25 percent of the creosote oil and pyridine. Soviet block countries (U.S.S.R., Poland, and Czechoslovakia) have supplied about 80 percent of the benzene imports, and 20 percent of the naphthalene; Germany shipped 22 percent of the naphthalene; and Great Britain furnished 30 percent of the imported creosote oil.

Japan is the leading coal-chemical-producing country in the Far East but requirements of the chemical industry in that country are greater than production and substantial quantities of certain coal chemicals are imported. The chemical industries of China and India are small but proposed expansion of heavy industry should also increase production of coal chemicals in these countries.

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PRODUCTION

Production data on crude light oil, tar, and ammonia (in terms of sulfate equivalent) for the 17 leading countries of the world are shown in table 1. Figure 1 illustrates graphically, production of these chemical raw materials for the 7 largest producing countries. Table 2 contains statistics on the most important tar and light-oil products for the same countries. A brief summary of production trends in the various countries and production statistics in as much detail as was possible to obtain from published bulletins, foreign-service dispatches, magazines, and other publications are presented on the following pages.

TABLE 1. - Production of basic coal-chemical materials in the leading producing countries of the world, 1956-58, in thousand metric tons [1]

	Crude tar			Crude light oil			Ammonia in terms of sulfate equivalent		
	1956	1957	1958 [2]	1956	1957	1958 [2]	1956	1957	1958 [2]
United States	3,779	3,963	3,037	967	993	735	885	920	670
U.S.S.R. [3]	1,996	2,100	2,206	601	632	663	738	777	815
West Germany	1,904	1,956	1,893	547	564	548	505	527	510
United Kingdom	2,910	2,907	2,640	477	487	518	324	345	324
France	694	711	725	130	133	127	113	115	110
Saar	223	228	226	64	62	60	33	35	34
Japan	620	632	600	118	131	124	116	128	122
Poland	412	430	437	133	139	140	106	111	115
China [4]	198	236	385	57	67	110	68	80	130
Czechoslovakia [5] ..	351	359	394	99	101	111	90	93	102
Belgium	248	252	254	96	95	92	85	82	75
Canada	236	[5] 224	194	[5] 55	[5] 52	45	36	[5] 34	29
Italy	177	184	166	35	40	36	[5] 61	[5] 64	58
Netherlands	169	171	162	51	54	51	[5] 30	[5] 32	30
Australia	284	275	280	[5] 47	[5] 45	46	[5] 45	[5] 43	45
India	78	114	133	[5] 35	[5] 37	43	15	23	27
Spain	85	100	106	[5] 27	[5] 30	31	[5] 21	[5] 23	25

[1] Data from official Government publications of respective countries, except as noted.

[2] Estimated for all countries except United States, West Germany, and Belgium.

[3] Data estimated from yields published in Russian trade journal, Koks i Khimiya, No. 11, 1957, pp. 43-46.

[4] Data estimated from yields as published in Russian trade journal, Koks i Khimiya, No. 10, 1958, pp. 60-63, and No. 11, 1957, pp. 43-47.

[5] Estimated.

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TABLE 2. - Production of principal derivatives of crude tar and light oil in leading producing countries of the world, 1956-58, in thousand metric tons 1/

	Benzene (all grades)			Other light oil distillates			Naphthalene			Tar oils			Pitch 2/		
	1956	1957	1958 3/	1956	1957	1958 3/	1956	1957	1958 3/	1956	1957	1958 3/	1956	1957	1958 3/
United States 4/	623	631	436	220	220	167	220	189	154	876	863	671	2,323	2,186	1,784
U.S.S.R. 5/	350	369	385	188	199	208	73	77	81	404	425	446	1,083	1,140	1,195
West Germany	428	474	499	96	89	70	88	99	93	721	766	736	936	965	982
United Kingdom	313	326	345	94	97	103	53	50	53	583	534	485	2,053	2,118	1,920
France	84	96	94	25	31	30	40	32	34	187	190	188	520	530	532
Saar	42	44	43	16	16	15	4	4	4	30	31	30	91	93	90
Japan	71	76	71	18	20	17	54	56	53	164	178	162	6/ 271	6/ 268	255
Poland	88	93	94	18	19	19	18	19	20	84	105	114	230	240	245
China 6/	34	40	66	14	19	31	5	5	8	30	31	50	90	100	163
Czechoslovakia 6/	52	54	59	27	28	31	7	7	8	70	72	79	170	175	192
Belgium	61	64	62	5	4	4	18	20	20	75	80	81	120	125	126
Canada	37	6/ 34	29	12	11	10	6/ 9	6/ 9	8	47	58	51	122	110	97
Italy	22	22	22	8	7	7	13	13	13	62	6/ 66	58	63	58	52
Netherlands	37	41	39	13	12	11	12	11	10	25	26	25	71	79	75
Australia 6/	40	39	40	(7/)	(7/)	(7/)	16	15	15	55	52	54	150	145	148
India	5	8	9	(7/)	(7/)	(7/)	1	1	1	6	6	6	44	31	36
Spain	17	23	24	(7/)	(7/)	(7/)	4	4	4	9	7	7	17	24	25

1/ Data from official Government publications of respective countries, except as noted.
2/ Includes road tar.
3/ Estimated for all countries except the United States, West Germany, and France.
4/ Does not include any benzene, toluene, or xylene made from petroleum or imported materials. Excluded also is crude tar used as fuel and imported naphthalene.
5/ Data estimated from yields published in Russian trade journal Koks i Khimiya, No. 11, 1957, pp. 43-47.
6/ Estimated.
7/ Included in benzene.

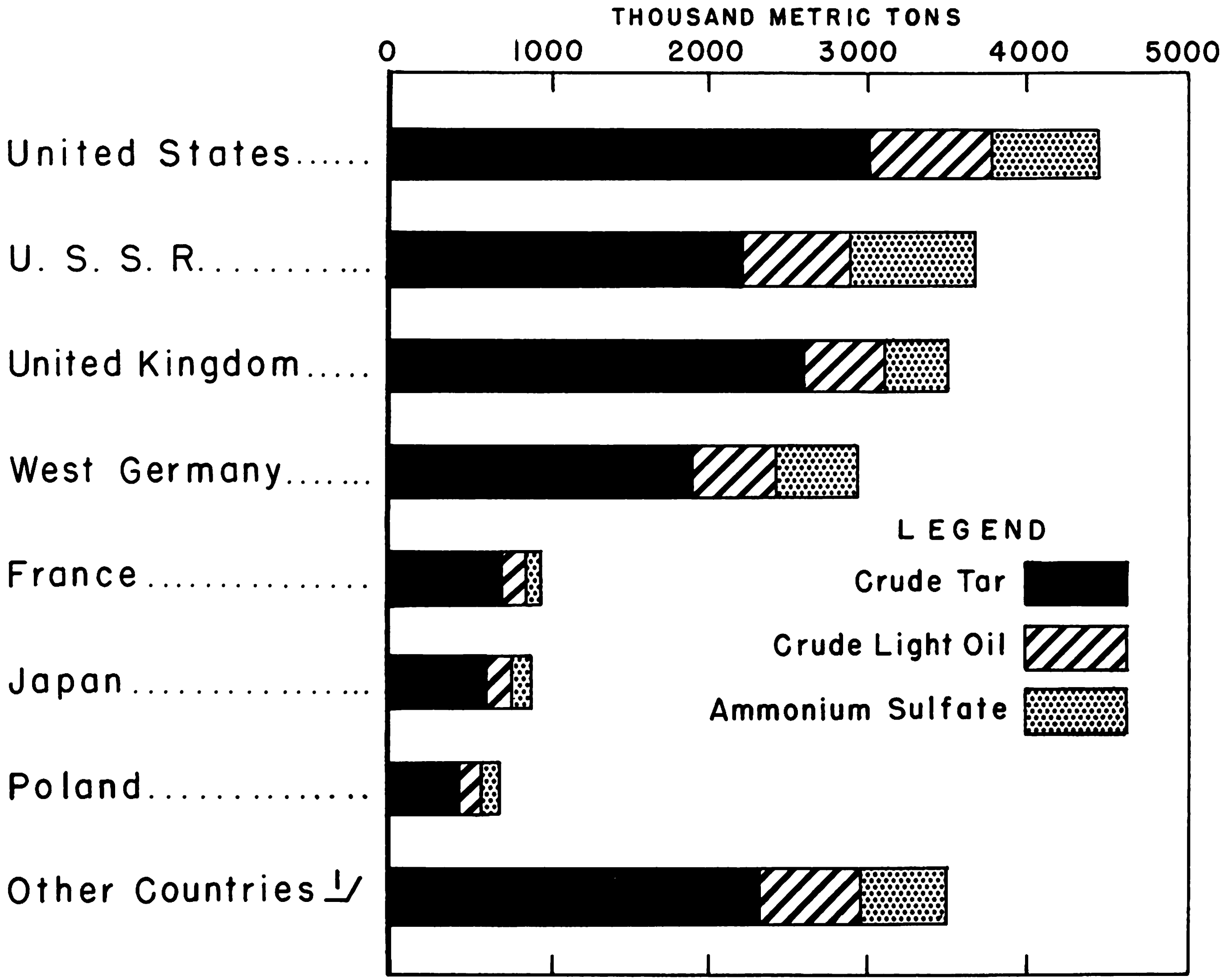

Figure I.- Production of Basic Coal-Chemical Materials in the leading producing countries of the World in 1958.

1/ Czechoslovakia, Belgium, Canada, China, Saar, Italy, Netherlands, Australia, India and Spain

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United States

Until World War I the organic chemical industry in the United States was so small that it was able to use only a limited amount of the coal chemicals produced by coal carbonization. During World War I the need for these products was great, but following the war, markets again disappeared. The depression of the 1930's also kept requirements low, although by the end of the 1930's the organic chemical industry was beginning to develop the massive markets that require tonnages of raw materials. World War II again created a great demand for coal chemicals, and much of this demand has been maintained since the war by the still-expanding chemical industry.

Removal and recovery of tar, crude light oil, and ammonia follow the same basic principals used in the early days of the oven-coke industry, but there have been many improvements in methods and equipment. In the past decade yields of these basic coal-chemical materials have not varied greatly, rising slightly during periods of low steel production when coking cycles are lengthened, and falling a little when coking cycles are shortened. Although yields have not changed markedly, production of each of the basic products (tar, light oil, and ammonia) has increased about 2 percent annually because of expansions in coal-carbonizing capacity. The potential producing capacity of the coke industry at the beginning of this year was around 1,040 million gallons of tar, 350 million gallons of light oil, and 300 thousand tons of ammonia.

The processing of crude light oil by coke-plant operators started a short time before World War I, and about 95 percent of the crude light oil currently produced in the United States is refined by producing companies in integrated facilities. The remaining 5 percent is sold to tar distillers and chemical companies, where the refining operations are conducted independently of the coke industry.

Roughly about 700 million gallons of tar is processed annually, about 40 percent by coke-plant operators and 60 percent by tar distillers. Only about 16 percent of our coke-oven crude tar production is burned currently as fuel compared with over 50 percent before World War II. This transition from a fuel to a source of chemical products has been of great importance to the chemical and allied industries. Instead of burning crude tar, some steel companies top their crude tar and in this way recover and market the distillates (naphthalene and tar acid oil) and utilize the resultant soft pitch in their metallurgical furnaces. Although the quantity of crude tar used as fuel has declined, the quantity of tar and pitch going into metallurgical furnaces has actually increased in the past decade.

Coke-oven ammonia is recovered in two forms: (1) An aqueous solution known as ammonia liquor and (2) a crystalline solid, such as ammonium sulfate and diammonium phosphate. In the early years of the coke-oven industry most of the ammonia was recovered as an aqueous solution, but today most of the ammonia (about 90 percent) is recovered as ammonium sulfate and less than 7 percent is recovered as

TABLE 3. - Production of coal chemicals in the United States, 1956-58, in thousand metric tons

Product	1956	1957	1958
Light-oil derivatives: 1/			
Benzene, all grades except motor	623	631	436
Benzene, motor	(2/)	(2/)	(2/)
Toluene, all grades	134	131	100
Xylene, all grades	38	39	30
Solvent naphtha	19	20	16
Other light-oil derivatives	29	30	21
Tar derivatives:			
Distillates:			
Creosote oil	589	567	468
Tar acid oil	154	136	98
Naphthalene, crude and refined	220	189	154
Other distillates 3/	133	160	105
Residue and pitch:			
Road tar	419	431	315
Pitch, all grades 4/	1,904	1,755	1,469
Ammonia products:			
Ammonium sulfate	800	825	581
Ammonia liquor 5/	63	61	52
Di- and mono-ammonium phosphate	22	34	37

1/ Derivatives obtained from coke-oven light oil produced in the United States; excludes production of derivatives from imported materials and from refining petroleum.

2/ Negligible.

3/ Phenol, cresols, cresylic acid, anthracene oil, and miscellaneous other tar products.

4/ Includes pitch coke.

5/ Sulfate equivalent

ammonia liquor. Diammonium phosphate, a new agricultural fertilizer from coke-oven gas, was made for the first time on a commercial basis by a coke plant in 1955. In 1958, approximately 4 percent of the United States total ammonia recovered from coal was converted into diammonium phosphate at three coke plants. Table 3 contains the latest data available on coal chemicals produced by carbonizing coal in the United States.

The American chemical industry has risen to its present stature within the last 40 years and an important factor in its dynamic growth is the steadily increasing utilization of chemical raw materials obtained by processing crude petroleum and natural gas. Until World War I the American chemical industry was based largely on inorganic chemicals. Synthetic organic chemicals obtained principally from coal carbonization became an important branch of the chemical industry between the two World Wars. Beginning with the defense program in 1939 and later during the war, requirements of chemicals for military needs increased far in excess of those that could be supplied from coal. Fortunately, the United States had sufficient reserves of crude petroleum and natural gas and the ingenuity to develop technical processes for producing toluene, xylene, cresylic acid, and other chemical products from these raw materials, and the deficits of toluene and other aromatic materials from coal were made up from petroleum processing. Toluene production from petroleum rose from less than 100 thousand gallons in 1940 to more than 150 million gallons in 1945, and by the end of World War II it was estimated that more than four-fifths of all of the national toluene production was derived from petroleum. In 1958 about 85 percent of our toluene supply was obtained from processing petroleum. Production of xylene and other aromatic materials, as well as the aliphatic hydrocarbons, increased just as rapidly. In 1958 the petroleum industry supplied over 90 percent of the xylene produced in the United States. Figures 2 and 3 compare production trends of toluene and xylene from coal and petroleum and clearly show the tremendous growth of the petroleum-based products.

No large quantities of benzene were made from petroleum until the early 1950's. The outbreak of war in Korea in 1950, however, increased requirements of benzene to a much higher level than could be supplied by coal, plus imports, and benzene-producing facilities were constructed at petroleum refineries. In 1950 only about 10 million gallons, or less than 2 percent, of the benzene produced from domestically-produced raw materials was made from petroleum fractions. Production of petroleum-derived benzene has increased rapidly, and by 1955 was nearly 100 million gallons, equal to about one-third of the total United States production from domestic raw materials. Current production from petroleum is running ahead of coal-derived benzene. Trends in production of benzene from coal and petroleum are shown in figure 4.

The potential of petroleum as a source of benzene, toluene, and xylene - referred to in trade circles as BTX - is tremendous. It has been estimated that currently only 11 percent of the available benzene, 6 percent of the toluene, and 4 percent of the xylene are recovered for chemical use. Supplies from petroleum sources can be expected to

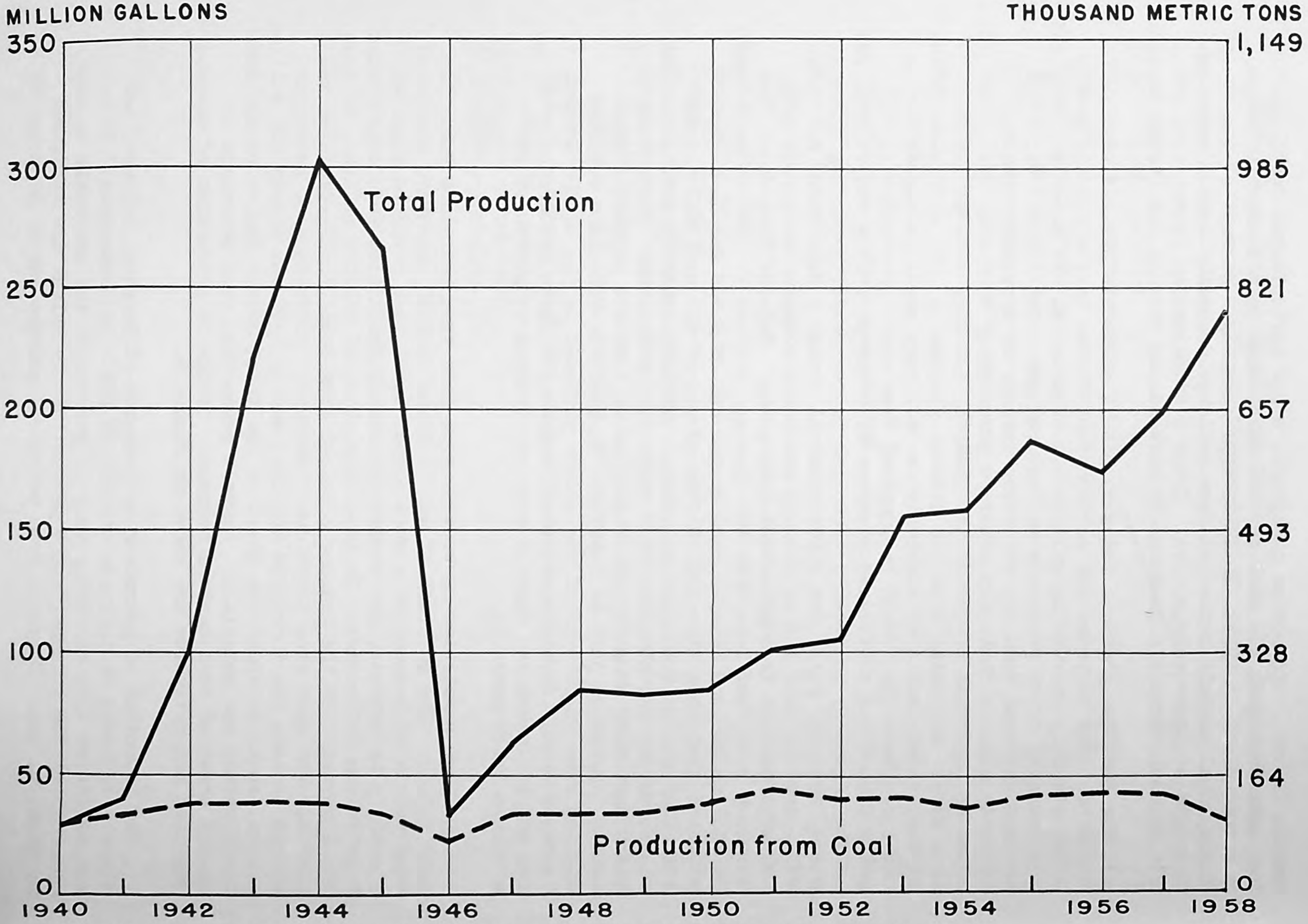

Figure 2.—Toluene Production in the United States, 1940—58

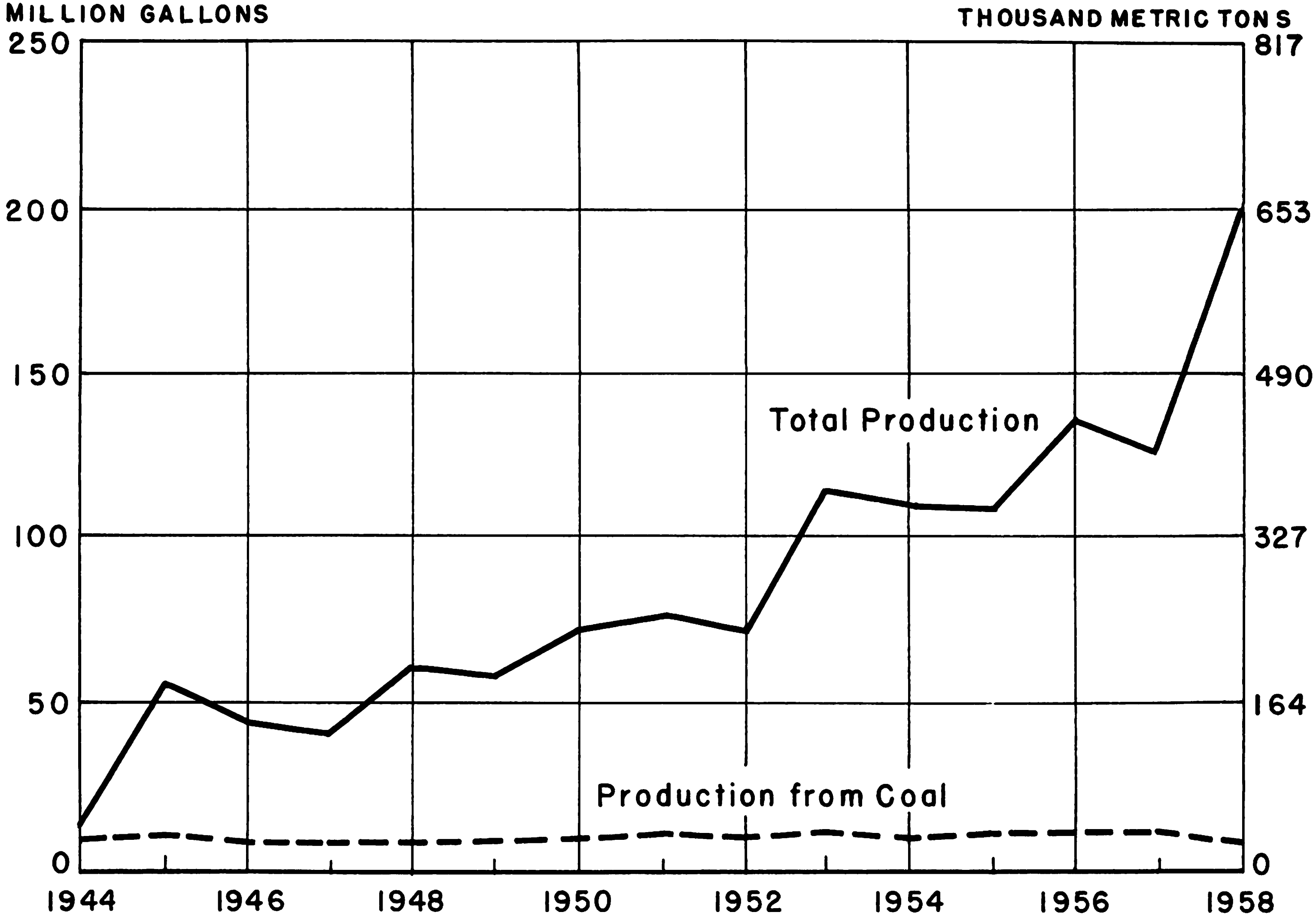

Figure 3.—Xylene Production in the United States, 1944-58

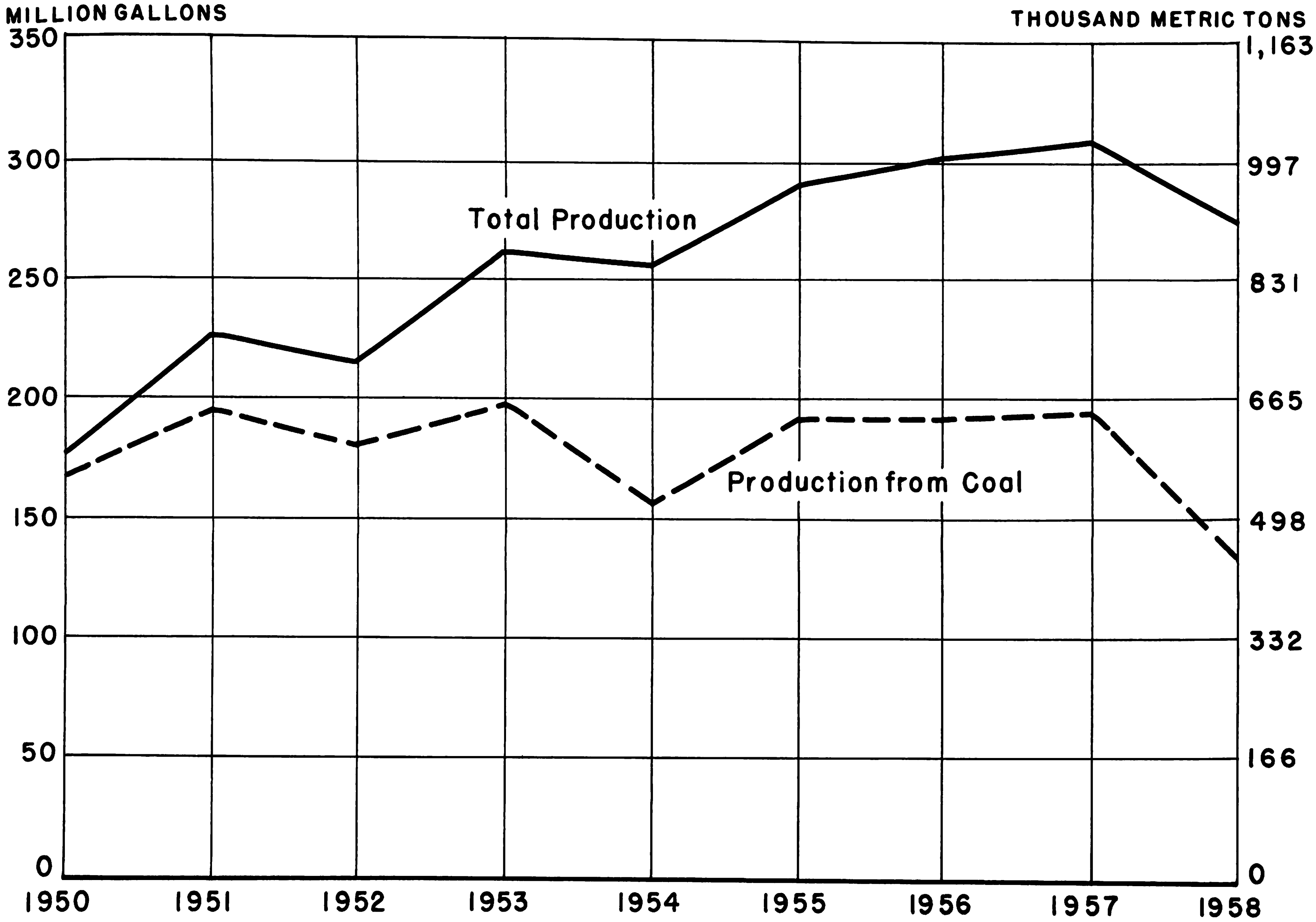

Figure 4.—Benzene Production in the United States, 1950–58

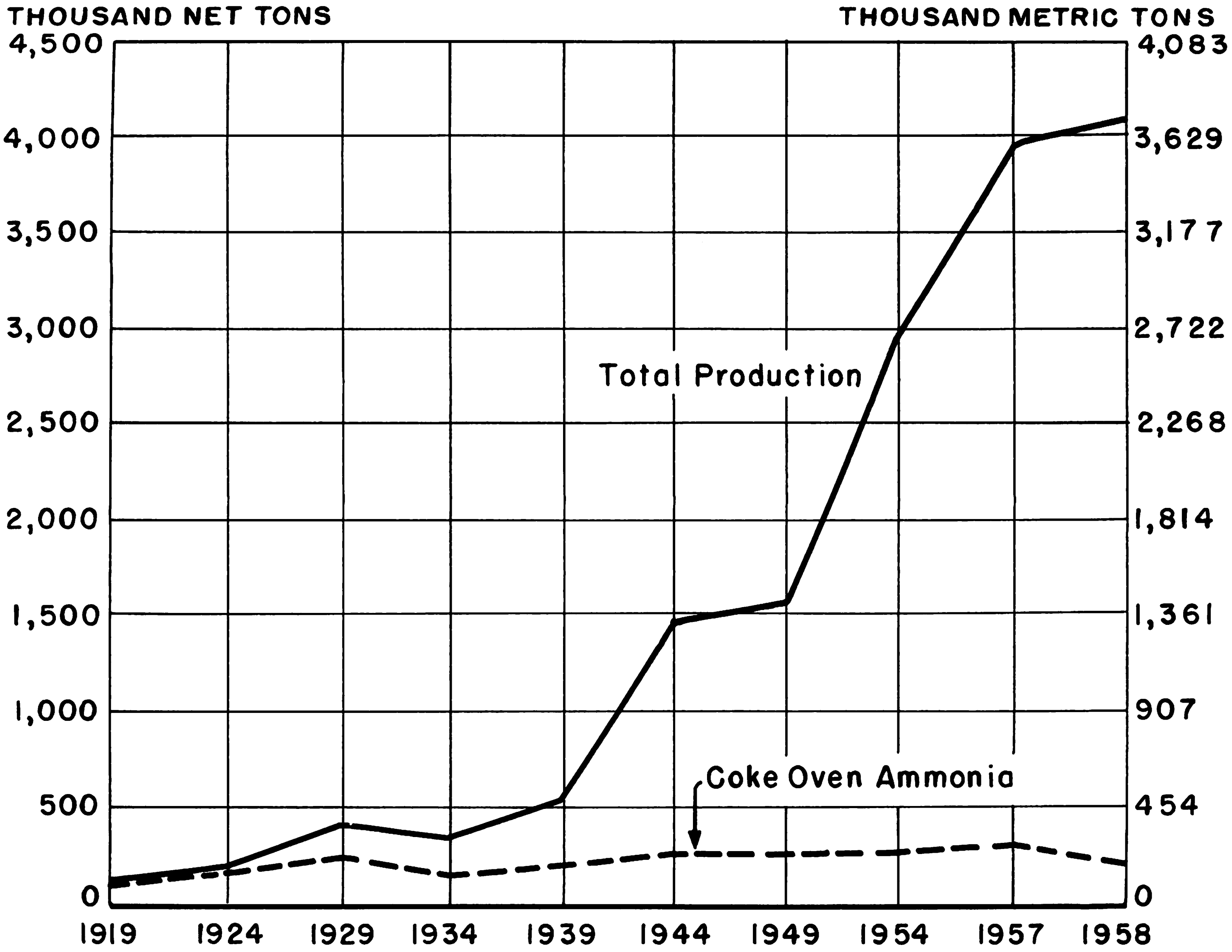

Figure 5.—Ammonia Production in the United States, 1919–58

increase as requirements for chemicals rise in keeping with our economic growth.

Chemical nitrogen was first produced in the United States by carbonizing coal, but coke ovens supply less than 5 percent of our current output, the balance being produced by synthetic processes (figure 5). Most of the synthetic processes use natural gas as the starting raw material.

U.S.S.R.

In the U.S.S.R., as in the United States, the emphasis in the coke industry has been on metallurgical coke to support the expanding steel industry. In the 10-year period 1949-58 the coal carbonizing capacity in the Soviet Union more than doubled, rising from approximately 32 million tons in 1949 to about 67.9 million tons in 1958. During this period production of crude tar and light oil from coal increased at a much faster rate in the U.S.S.R. than anywhere in the world including the United States (figure 6). According to data published in the Russian trade journal, Koks i Khimiya, yields of crude tar and crude light oil are slightly lower than those in the United States, while ammonia yields are about 20 to 25 percent higher. On the basis of this information, tables 4 and 5 were prepared showing yields and estimated production of the principal coal chemicals in the U.S.S.R. for the period under review. Although 1957 and 1958 are only estimates, based on yields reported for 1955-56, it is believed they were close to the actual output of these commodities.

In 1958 a 6 to 7-year experimentation plan was proposed, which if carried out, will enable the U.S.S.R. to process their tar more effectively. [5] According to this report, approximately 200,000 metric tons, or about 8 percent, of the total tar output is used without any processing and probably is used as fuel. The proposal states that this practice should be stopped completely and modern continuous tar distillation facilities be constructed to process the tar. The new tar distillation plants are expected to improve the quality and increase the yield of the distillates. In the past, it was reported, the quality of naphthalene, creosote oil, and anthracene was poor and the pitch yield was high. In 1941, the yield of pitch from tar processing was 63 percent. It had declined to 52 percent by 1956 and the proposed goal is to reduce pitch yields further. According to a tabulation in this article, the Soviets are going to try and attain the following yields in the new tar processing plants:

	Percent
1. Light oil for benzene rectification plants	0.5
2. Phenol from phenol fractions as well as phenolates from other sources	1.6
3. Tar bases	0.7

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[5] Nosalevich, I. M., Development of the Types of Primary Products of Processing Hard-Coal Tars, Koksokhimicheskoye Proizyodstvo, Moscow, 1958.

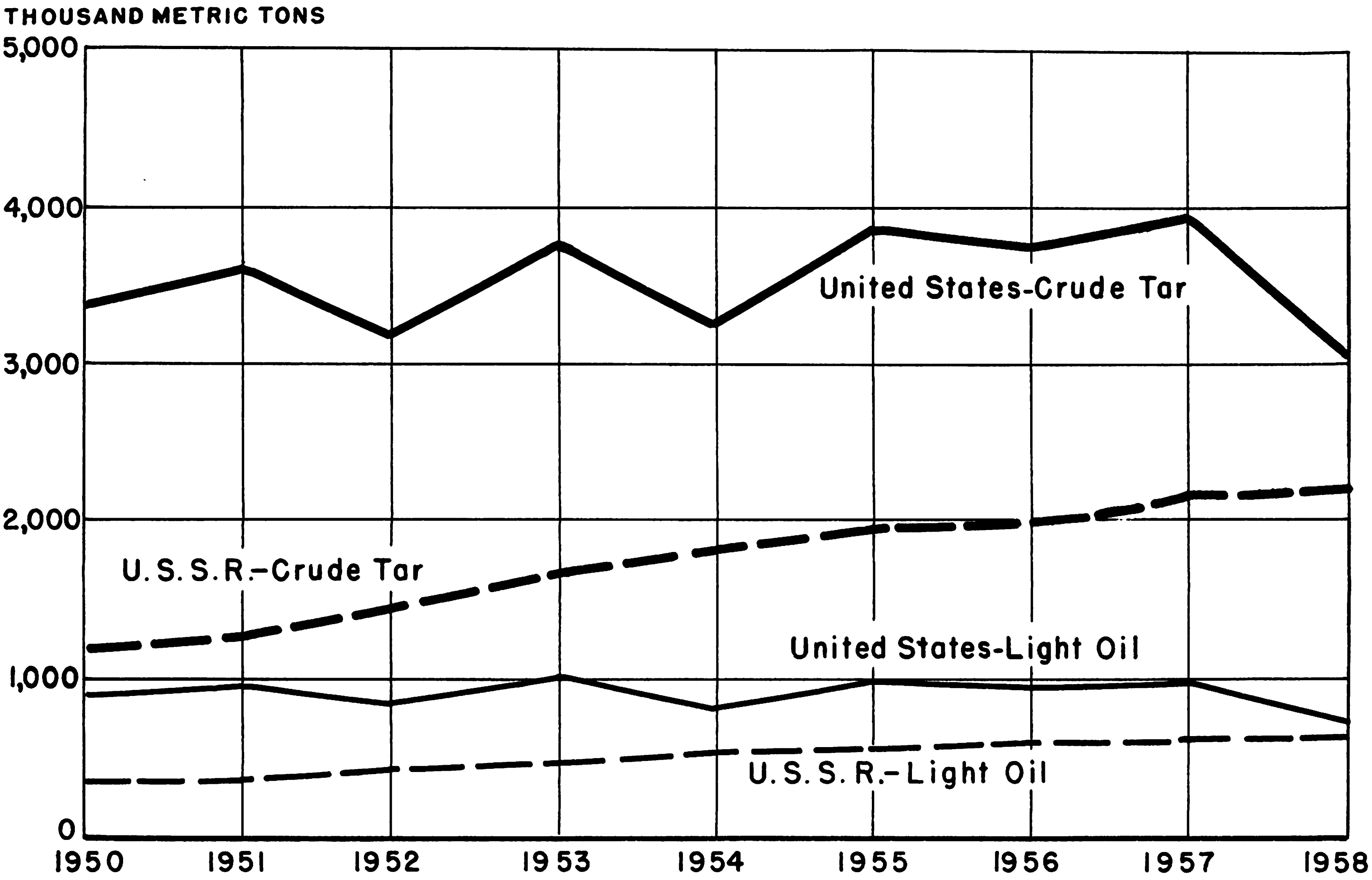

Figure 6.- Production of Crude Tar and Light Oil in the United States and U.S.S.R., 1950-58.

TABLE 4. - Yields of basic coal-chemical materials and derived products in the U.S.S.R., 1955-58

	1955	1956	1957	1958
Coke production, million metric tons 1/	43.6	46.2	48.6	50.9
Dry coal carbonized, million metric tons 2/	58.1	61.6	64.8	67.9
Yield of coal-chemical materials per ton of coal carbonized, percent: 1/				
Crude tar	3.26	3.24	3.24	3.24
Crude light oil	0.972	0.976	0.976	0.976
Ammonia	0.299	0.309	0.309	0.309
Yield of light-oil derivatives, percent: 1/				
Benzene	58.3	58.3	58.3	58.3
Toluene	17.2	17.2	17.2	17.2
Xylene	14.2	14.2	14.2	14.2
Yield of tar products, percent: 3/				
Creosote oil	22	22	22	22
Naphthalene	4	4	4	4
Pitch	59	59	59	59

1/ 1955-56 from Koks i Khimiya, No. 11, p. 47; 1957-58 estimated.
2/ Estimated on the basis of 75 percent coke yield.
3/ Belov, Khimicheskiye Produkty Koksovaniya, 1949.

TABLE 5. - Estimated production of light-oil and tar derivatives in the U.S.S.R., 1955-58, in thousand metric tons

	1955	1956	1957	1958
Quantity of light oil processed	565	601	632	663
Light-oil derivatives produced:				
Benzene	329	350	369	385
Toluene	97	103	109	114
Xylene	80	85	90	94
Percent of tar production processed 1/	91	92	92	92
Quantity of tar processed	1,724	1,836	1,932	2,030
Tar derivatives produced:				
Creosote oil	379	404	425	446
Naphthalene	69	73	77	81
Pitch	1,017	1,083	1,140	1,195

1/ 1955-56 from Koks i Khimiya, No. 11, p. 47; 1957-58 estimated.

		Percent
4. Heavy solvents including neutral oils		0.8
5. Compressed naphthalene		6.5
6. Tar oils for the recovery of crude light oil		3.5
7. Anthracene		0.8
8. Technical oils		33.6
a. High quality creosote oil	20.0	
b. Oil for producing carbon black	5.7	
c. Oil for insecticides	1.2	
d. Oil for flotation reagents	0.2	
e. Oil for production of road tar	5.0	
f. Oil for heating purposes	1.5	
9. Pitch of various types		52.0

It is apparent from this information that tar refining techniques in the Soviet Union will be designed to produce a wide range of products and output of the various products, no doubt, will be governed in accordance with demands for each. Data on light-oil processing were not available to the authors, but from the quantity and quality of benzene entering the United States from the U.S.S.R. it would be reasonable to assume that light-oil refining techniques in that country are similar to those in the United States.

Currently, most of the coke-oven ammonia recovered from coal carbonization is converted into ammonium sulfate. An article in the May 1959 issue of Koks i Khimiya (Coke and Chemistry) stated that six Soviet coke plants will be using coke-oven gas for making synthetic ammonia by 1965. In 1958 the State Planning Commission (GOSPLAN) approved a program for raising the coke-production goal somewhere between 75 and 81 million metric tons by 1965. 6/ This new target represented an increase of 50 to 58 percent over the 1958 production and indicated a yearly growth of 3.6 to 4.2 million tons. The total increase in coke production will in turn increase the output of basic coal-chemical materials in almost direct proportion and production of light oil and tar derivatives can be expected to rise substantially.

GERMANY

Germany ranks fourth among the leading tar-producing countries of the world and third in crude light oil and coke-oven ammonia output, but ranks second to the United States in benzene and naphthalene production. This is due to the high degree of development of the coal-chemical industry in Germany, particularly in light-oil-refining techniques.

Benzene production has been increasing steadily in recent years and in 1958 Germany led the world in production of coal-derived benzene with an output of 499 thousand metric tons. This was about half the quantity produced in the United States from all sources, but all of it

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6/ Koks i Khimiya, No. 1, January 1959, p. 3.

was from coal whereas more than half of the benzene produced in the United States from domestically-produced material was from petroleum. Processing of crude tar in Germany goes back many years and virtually all of the tar is processed. Distillation of tar in Germany yields about 9 percent tar acid bases, 33 percent tar oils (creosote oil), and 58 percent pitch. Table 6 shows production of light oil and tar derivatives in Western Germany in 1956-58.

Ammonia from coke-oven gas is rather unimportant in the overall ammonia production in West Germany. In 1958, 1,492 thousand tons of ammonia was produced, of which 91 percent was synthetically produced and 9 percent came from coke-oven plants.

Although about 75 percent of the total West German production of organic chemicals is derived from coal, the petrochemical industry has been expanding rapidly. In 1958 the production of petroleum chemicals increased 13 percent over 1957, reaching 187 thousand tons, in terms of carbon content. Petrochemicals now being produced from petroleum that will be produced in greater quantity in the future are: ethylene, ethanol, methanol, ammonia, polyethylene, ethylene glycol, propylene, and solvents. Unlike the United States, however, where more benzene is made from petroleum than from coal, all of Germany's benzene is derived from coal, and present plans call for continuation of this procedure.

TABLE 6. - Production of light oil and tar derivatives in West Germany, 1956-58, in thousand metric tons

Product	1956	1957	1958
Light oil derivatives: 1/			
Benzene, pure	149	150	175
Benzene, motor	279	324	324
Toluene	30	31	28
Xylene	15	14	12
Other light oil distillates	51	44	30
Tar derivatives:			
Naphthalene	88	99	93
Creosote oil	644	684	657
Anthracene	40	41	40
Cresols and xylenol	19	21	21
Phenol	11	12	13
Other tar distillates	7	8	5
Pitch	936	965	982

1/ Distillates include some imported materials that are upgraded.

United Kingdom

The United Kingdom carbonizes more coal in coal-gas retorts than any other country in the world. In 1958 about 46 percent of the coal carbonized in the United Kingdom was charged into gas retorts. As most of the gas plants employed vertical retorts, which produce a higher yield of tar than either high-temperature horizontal retorts or coke ovens, yields of tar per ton of coal in the United Kingdom are higher than in any other country. Thus, although the United Kingdom carbonized less coal than either the U.S.S.R. or Germany, its tar production substantially exceeded that of these two countries in 1958. The processing of tar is highly developed in Great Britain and virtually all of the output is distilled. The bulk products produced by distilling are creosote oil, road tar, and pitch.

Production of crude light oil has been increasing steadily and in 1958 was about 6 percent higher than in 1957, amounting to about 518 thousand tons. Production of benzene, toluene, and xylene increased in about the same proportion as light oil. The only basic coal chemical that declined in output in Great Britain in 1958 was creosote, which fell about 9 percent. Table 7 shows production of crude tar and light oil derivatives for 1956-58.

The portion of the British chemical industry that has been expanding most rapidly in the past several years is petrochemicals. The output of petroleum chemicals increased 19 percent in 1958 and amounted to approximately 327 thousand metric tons in terms of carbon content. This equaled about 50 percent of the entire output of organic chemicals, and estimates indicate that the petrochemical share of organic-chemicals output will be between 65 and 75 percent by the mid-1960's.

France

Chemical production in France continued at a high rate in 1958, and France ranked fifth among the world chemical-producing countries. Both organic and inorganic production increased slightly in 1958, but the rate of growth was greatest in organics.

Although France has a booming petrochemical industry, the major source of organic raw materials is coal, from which about 85 percent of the organic chemicals was produced in 1958. Crude tar and light oil production has increased only slightly since 1956 but production of pure and refined products is increasing appreciably each year. Virtually all of the tar is distilled, yielding pitch, tar oils, and naphthalene. Major light-oil products recovered are benzene, toluene, xylene, and solvent naphtha. Two other chemical products, ethylene and methanol, are obtained from coal in France and have acquired new importance. Although not generally regarded as coal chemicals, they are being produced from coke and coke-oven gas, and substantial quantities of both are now being consumed by the plastics industry. Ethylene is extracted directly from coke-oven gas and this practice has become an integral part of the recovery process. Production data on

TABLE 7. - Production of light oil and tar derivatives in the United Kingdom, 1956-58, in thousand metric tons

Product	1956	1957	1958
Light oil derivatives:			
Benzene, pure	105	133	141
Benzene, motor	208	193	204
Toluene	37	36	38
Xylene	15	17	18
Other light oil distillates	42	44	47
Tar derivatives:			
Naphthalene	53	50	53
Cresols	66	69	63
Phenol	14	15	14
Creosote oil	498	445	404
Anthracene	3	3	3
Other tar distillates	2	2	1
Road tar	618	600	544
Pitch/creosote mixture	892	1,064	965
Pitch	543	454	411

TABLE 8. - Production of light oil and tar derivatives in France, 1956-58, in thousand metric tons

Product	1956	1957	1958 1/
Light oil derivatives:			
Benzene, pure	39	60	60
Benzene, motor	45	36	34
Toluene	15	21	20
Xylene	4	4	4
Other light oil distillates	6	6	6
Tar derivatives:			
Naphthalene	40	32	34
Phenol, cresols, and xylenol	15	17	11
Creosote oil	157	158	161
Other tar distillates	15	15	16
Road tar	313	313	314
Pitch	207	217	218

1/ Estimated on basis of 1957 yields.

light oil and tar derivatives in 1956-58 are shown in table 8.

Production of petrochemicals was 78 percent greater than in 1957 and reached 142 thousand tons. Ethylene produced from refinery gas is becoming increasingly important in supplying the growing demands for ethylene oxide, polyethylene, and polystyrene. Other petrochemicals of importance are phenol and acetone, of which 30 thousand and 28 thousand metric tons, respectively, were produced in 1957, the latest figures available.

Saar

The Saar produced 320 thousand tons of coal chemicals in 1958, and most of the crude chemicals were refined into pure products. Light-oil distillates included 43 thousand tons of motor and refined benzene and 15 thousand tons of toluene, xylene, and solvent naphtha. About four-fifths of the crude tar produced in the Saar was distilled. Of the tar processed, about 40 percent was shipped to distilling plants in France. As far as can be determined, no chemicals are produced from petroleum in the Saar.

Japan

The Japanese chemical industry has expanded rapidly in the past few years, and Japan now ranks sixth in world-chemicals production. Japan's main source of hydrocarbons is coal carbonization and the production of basic chemicals is closely associated with that of iron and steel. In the past few years, however, despite record production of coke, iron, and steel, the demand for chemicals exceeded output, and large quantities were imported.

Output of basic coal-chemical materials in 1958 decreased slightly from 1957 and was estimated at 846 thousand metric tons. Production of benzene, toluene, xylene, anthracene, and phenol was also slightly lower than in 1957 (table 9).

Chemical fertilizers represent the largest part of the Japanese chemical industry and compose about 30 percent of the total chemical production. Ammonium sulfate is Japan's most important chemical product, and output in 1958 totaled 2.6 million tons. However, only 5 percent of the total was produced at coke plants, as the bulk was produced synthetically from coal and coke.

The rapid growth in Japan of the synthetic-resins and plastics industries, as well as nylon, vinyl acetate, and other synthetic-fiber industries, has brought new demands for organic chemicals; and within the past few years, limited amounts of chemicals have been produced from petroleum and natural gas. Japan's petrochemical industry is still very small but, by May 1957, eight companies had entered this field and were either producing or building facilities. It is expected that within a short time the petrochemical industry will alleviate Japan's present

TABLE 9. - Production of light oil and tar derivatives in Japan, 1956-58, in thousand metric tons

Product	1956	1957	1958
Light oil derivatives:			
Benzene, pure	70	72	70
Benzene, motor	1	4	1
Toluene	6	7	6
Xylene	5	6	5
Other light oil distillates	7	7	6
Tar derivatives:			
Naphthalene	54	56	53
Phenol	7	7	7
Creosote oil	152	165	150
Anthracene	5	6	5
Pitch	271	268	255

shortage of chemicals such as benzene, phenol, and acetone and also supply other chemicals such as the ethylene group which were heretofore imported.

Poland

Poland now ranks seventh in production of crude coal chemicals, as production in 1958 reached 692 thousand tons. However, Poland lacks adequate facilities for processing crude tar and light oil, and a large part of the production is only partially refined. According to data published in Polish trade journals (Chemik, No. 6, 1958, and Gospodarka Planove, No. 2, 1958), production of crude tar and light oil had doubled since 1950, with production in 1958 at 437 thousand tons for tar and 140 thousand tons for light oil. Tar products are chiefly creosote, naphthalene, and pitch, and these commodities are being produced in increasingly greater quantities because of increased demands for road tar, railroad-tie impregnating oils, briquet binders, and phthalic anhydride. The principal light-oil distillate was motor benzene, because light-oil-refining facilities are inadequate and only limited quantities of pure products were produced. Roughly 70 percent of the Polish benzene production was motor benzene (table 10). Plans, however, call for increased investments in light-oil- and tar-distillation equipment and a 60-percent increase in refined products is anticipated within the next 15 years.

TABLE 10. - Production of light oil and tar derivatives in Poland, 1956-58, in thousand metric tons

Product	1956	1957	1958
Light oil derivatives:			
Benzene, pure	18	19	19
Benzene, motor	70	74	75
Toluene	14	15	15
Xylene 1/	4	4	4
Tar derivatives:			
Naphthalene	18	19	20
Phenol	6	7	8
Creosote oil	58	57	62
Anthracene	17	37	40
Other tar distillates	3	4	4
Pitch	230	240	245

1/ Includes solvent naphtha and other light-oil distillates.

China

The chemical industry in Communist China is still relatively undeveloped, but much progress is reported to have been made in developing all industries, and building a chemical industry is part of the Government's overall industrialization policy.

Very little has been published on chemicals production in China. Data published in the Russian trade journal, Koks i Khimiya, however, lists yields of basic chemicals for 1957 at 3.12 to 3.85 percent for tar and 0.80 to 1.20 percent for light oil. Coke production in recovery-type ovens for 1958 is estimated at 8,500 thousand metric tons and from these yields we estimate that crude tar production in 1958 was 385 thousand tons and light oil production 110 thousand tons. No data were given for ammonium sulfate production, but as average tar and light oil yields approximate those of other countries, it may be assumed the ammonia yield would also be comparable and production of ammonium sulfate was estimated at 130 thousand tons. Coke production in this country has been reported to have increased more than 400 percent since 1950 and coal chemicals are becoming increasingly available. The Government, however, considers its chemical industry the "weakest link" and has launched an ambitious five-year building program. At the end of this period production of basic chemicals is expected to be three times the present output.

A petrochemical industry has not been developed in China.

Czechoslovakia

Czechoslovakia produced about 8 million tons of high-temperature-oven and gas-house coke in 1958 and recovered an estimated 607 thousand tons of crude products. Current figures on chemical production in Czechoslovakia are not available; but, on the basis of data published in 1945-46, output of crude tar, light oil, and ammonium sulfate has been calculated at 394, 111, and 102 thousand tons, respectively, for 1958.

Belgium

Production of coal chemicals in Belgium is increasing and output in 1958 reached 421 thousand tons. The Belgian organic-chemical industry is based almost entirely on coal, although a few organics are made by fermentation and other processes. Basic coal chemicals produced in 1958 were 254 thousand tons of tar, 92 thousand tons of light oil, and 75 thousand tons of ammonium sulfate. Prior to 1958 no chemicals were produced from petroleum in Belgium. However, one plant was completed and placed in operation in 1958. The principal chemicals this plant produces are ethylene oxide and derivatives, acetone, phenol, and raw materials for detergents.

Other Countries

As it was impossible to include in this review all countries of the world that produce coal chemicals, only those countries that carbonized over three million tons of coal were covered. Countries which carbonized between three and six million tons of coal in 1958 were the Netherlands, Canada, Italy, Australia, India, and Spain. Production of coal chemicals in these countries is increasing because of the advancing iron-making capacities which naturally require greater quantities of coke.

A slackening in industrial activity in the Netherlands, Canada, and Italy in 1958 caused production of the basic coal-chemical materials to decline slightly from 1957 whereas production increased in Australia, India, and Spain.

Since the end of World War II, the chemical industry in Italy has developed rapidly and is now more than three times larger than it was before the war. Although production of coal chemicals has increased greatly, they have not kept pace with expanded requirements and substantial quantities of benzene, toluene, naphthalene, and other coal-tar derivatives have been imported. In order to cut down on these imports, Italy had developed a petrochemical industry and produced 130 thousand metric tons of petrochemicals in 1958, a 78 percent increase over 1957. Although production of coal chemicals declined slightly in the Netherlands in 1958, production of petrochemicals increased 22 percent, rising to 45 thousand metric tons.

The completion of a new coke plant at Durgapur in West Bengal, India, (near Calcutta) in December 1958 should increase the production of coal chemicals in that country. New coking capacity recently completed in Australia will also raise output of coal chemicals in that country. Production of coal chemicals have increased slowly but steadily in Spain and in 1958 were about 20 percent higher than in 1956.

CONSUMPTION

United States

The bulk of the basic coal chemicals produced in the United States are consumed therein for manufacturing intermediate and end products. In addition, about 20 percent of the crude naphthalene consumed in the United States since 1955, 15 percent of the benzene, 25 percent of the creosote oil, and larger percentages of cresols have been imported. The United States currently consumes between one-third and one-half of the world's output of pure benzene, toluene, xylene, and naphthalene. About the only basic coal chemical that the United States exports more than it imports is ammonium sulfate; it is estimated that about 32 percent of the coke-oven production was shipped to foreign countries in 1956-58.

Tar and light-oil products are starting materials for hundreds of end products and consequently have countless applications. Creosote oil is used mainly as a wood preservative for treating railroad crossties, telephone and utilities poles, highway guardrails, pilings, fence posts, and mine timbers. According to data published by the United States Department of Agriculture in cooperation with the American Wood-Preservers Association, creosote or a creosote solution was used in 1957 for 80 percent of all the materials given preservative treatment. Petroleum pentachlorophenol supplied 13 percent of the demand, and all other preservatives combined supplied 7 percent.

Naphthalene has many uses, but about 80 percent of our national consumption is used to make phthalic anhydride, which in turn is used to make alkyl resins and plasticizers. The remaining 20 percent is employed for many purposes, such as household preparations and insecticides, dyes, medicines, tanning agents, and oil additives.

In processing tar, roughly 50 to 80 percent of the tar remains as pitch. Coke-plant operators that partly distill or top their tar sell the distillate (crude chemical oil) to chemical companies for further processing and burn the residual tar or pitch in metallurgical furnaces. In 1957 coke-plant operators that processed tar used 93 percent of the pitch they produced and sold the remainder. Tar distillers, however, market the pitch recovered from their refining operations for many industrial applications, such as binders for carbon electrodes, roofing materials, protective coatings on pipes, and for numerous other purposes. Some of the pitch is carbonized to make pitch coke for carbon electrodes, but most of the coke for carbon electrodes is obtained from the petroleum industry because of a price advantage.

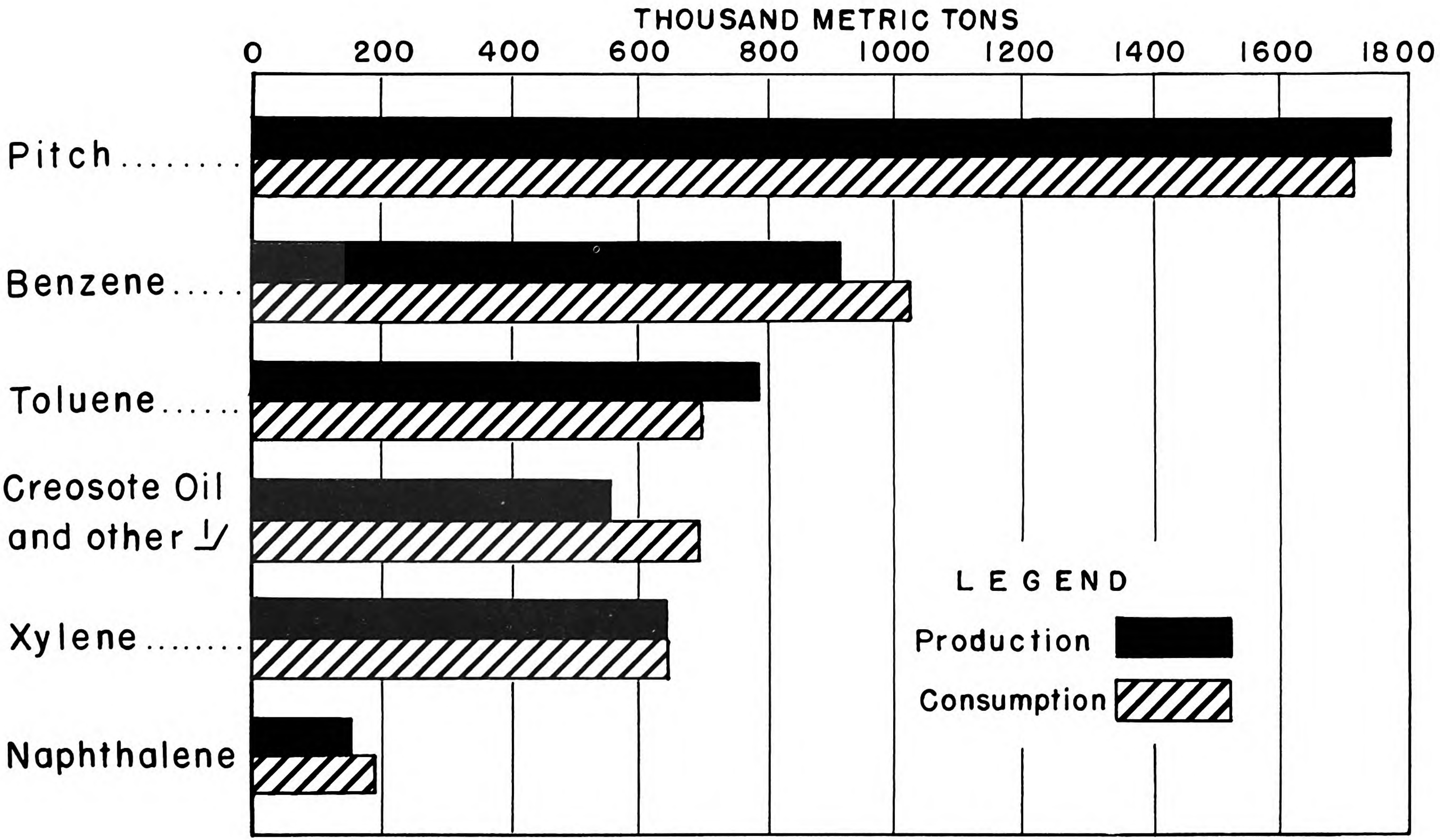

Figure 7.—Production and apparent consumption of Light Oil and Tar Products in the U.S., 1958[2]

[1] Other Tar Distillates

[2] Includes Benzene, Toluene and Xylene made from petroleum

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Current uses of benzene, toluene, and xylene are well established and generally known. The two largest uses for benzene are for making styrene and synthetic phenol, which currently require about 40 and 20 percent, respectively, of our total consumption. Requirements of benzene for manufacturing synthetic detergents are increasing steadily and now represent about 10 percent of our total consumption; about 9 percent goes into the manufacture of synthetic fibers such as nylon; 4 and 3 percent, respectively, for aniline and DDT; and the remainder (14 percent) for miscellaneous purposes.

About half of our toluene production is used in aviation gasoline; 10 to 20 percent for explosives; 8 to 10 percent in protective coatings and as solvent in the paint industry; and the remainder (about 20 percent) in chemical synthesis.

The principal uses for xylene are for making protective coatings and as solvents, which utilize about 48 percent; 29 percent is used in aviation gasoline; and the remainder is separated into the isomers - ortho, meta, and para - and used in chemical synthesis (table 11).

Most of the ammonia recovered from coal is converted into sulfate and marketed as agricultural fertilizer. Diammonium phosphate produced in the coke industry is also marketed as fertilizer. Ammonia liquor, which contains about 9 percent of the ammonia recovered from coal, is marketed both for agricultural and industrial purposes. It is estimated that about half of the ammonia liquor goes into agriculture and the balance to industry.

TABLE 11. - Apparent consumption of light oil and tar products in the United States in 1958, in thousand metric tons 1/

Product	Production	Imports	Exports	Apparent consumption
Benzene	911	148	38	1,021
Toluene	788	2	84	706
Xylene	654	1	(2/)	655
Pitch	1,784	1	58	1,727
Tar oils	671	137	3	805
Naphthalene	154	37	(2/)	191

1/ Includes benzene, toluene, and xylene made from petroleum.
2/ Not separately classified; however, total exports are small and not significant.

U.S.S.R.

Data on consumption, by uses, of coal chemicals in the Soviet Union are sketchy and only estimates can be made. Table 12 has been prepared to show the output, exports, and apparent consumption of the principal tar and light oil derivatives for 1957 from information published in magazines. According to Soviet trade journals about 60 percent of the raw materials used to produce plastics, synthetic fibers, synthetic

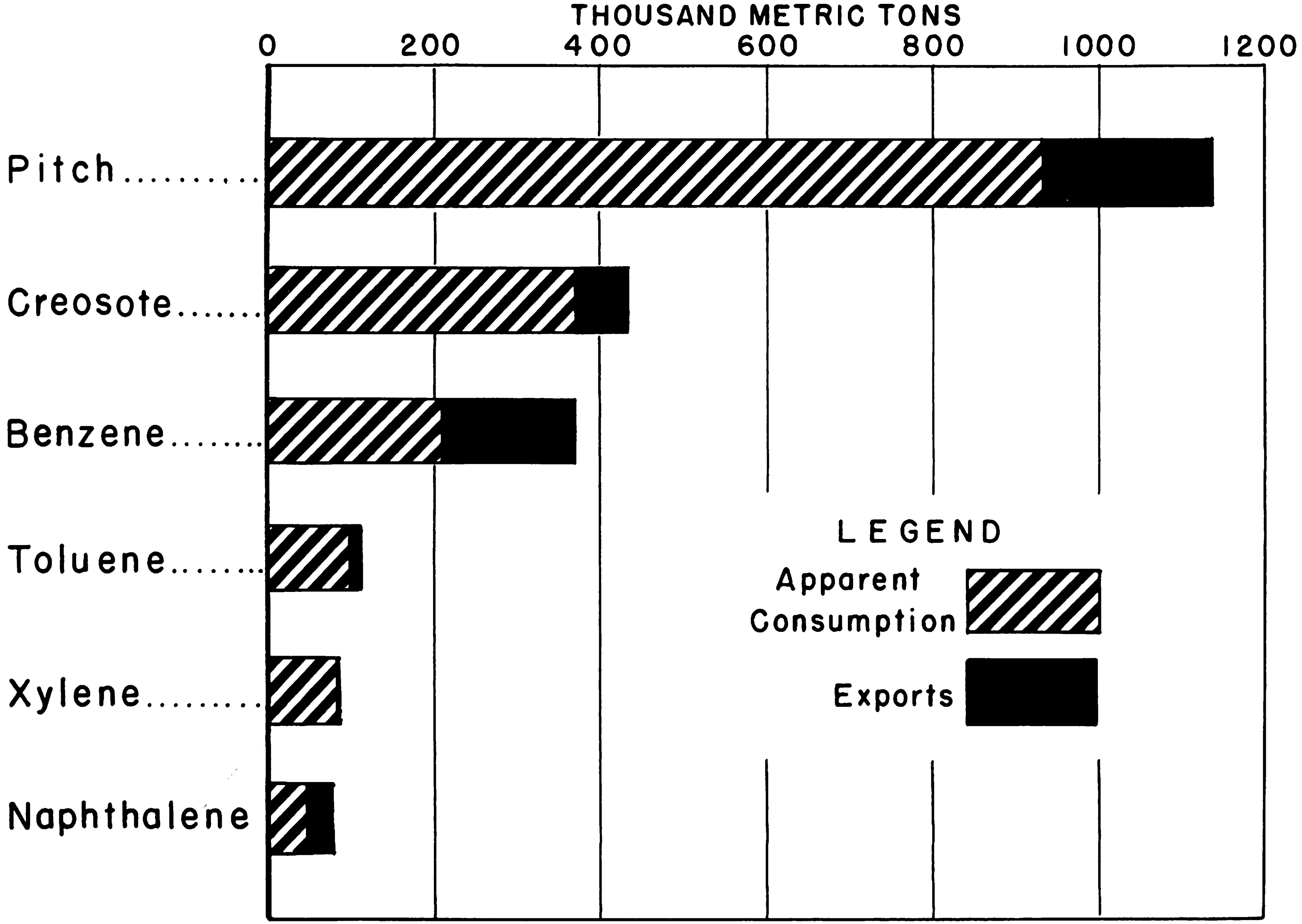

Figure 8.– Apparent Consumption and Exports of Light Oil and Tar Products in U.S.S.R., 1957

TABLE 12. - Production, imports, exports, and apparent consumption of certain light oil and tar products in the U.S.S.R. in 1957, in thousand metric tons

Product	Production	Imports	Exports		Apparent consumption	
			Quantity	Percent of production	Quantity	Percent of production
Tar oils (creosote oil)	425	(1/)	58	13.6	367	86.4
Naphthalene	77	(1/)	37	48.1	40	51.9
Pitch	1,140	(1/)	206	18.1	934	81.9
Benzene	369	(1/)	165	44.7	204	55.3
Toluene	109	(1/)	14	12.8	95	87.2
Xylene	90	(1/)	1	1.1	89	98.9

1/ Negligible.

detergents, and other products are derived from coal. However, as the coke industry has expanded faster than the chemical industry, only about 50 percent of the light-oil products are utilized for chemical synthesis because of lack of facilities to make synthetic phenol, styrene, and other benzene-based derivatives. The surplus is disposed of for nonchemical uses, such as motor fuel, or exported. The same situation is true for naphthalene, and it has been reported that only about 60 percent of the output is used in the chemical industry owing to shortages of facilities for making phthalic anhydride and other intermediates. Because of these conditions, it is estimated that approximately 40 percent of the benzene output of the Soviet Union is exported, 18 percent of the toluene, 40 percent of the naphthalene, and 22 percent of the pitch. The Commission of GNTK (Government Scientific-Technical Committee) of the Council of Ministers of the U.S.S.R. on coke-chemical raw materials and semiproducts (byproducts) held a meeting in December 1958 on the use of coke-chemical products in the current 7-year plan ending in 1965. 7/ This commission estimated that construction of new plants for the production of plastics, synthetic fibers, and other synthetic materials will increase benzene requirements 2.4 times more than the 1959 figure by 1965. In 1965 about 67.7 percent of the benzene requirements will be obtained from coke ovens and the balance or 32.3 percent from the oil industry (petroleum). It was estimated that the 1965 requirements of solvents for the lacquer and dye industries will be 3 times greater than in 1959 and naphthalene requirements will increase tremendously because of a 6-fold increase in phthalic anhydride production. It is reasonable to assume that the high proportion of output of the various coal chemicals currently exported will be reduced as new facilities are installed to make plastics, synthetic rubber, and other end products which will naturally require more benzene and naphthalene. In addition, Soviet plans include an increase in production of pharmaceuticals, vitamins, and rubber-processing chemicals. Although increasing quantities of coal chemicals will be required to produce the end products mentioned above, total production is expected to exceed requirements for the next several years and considerable quantities of benzene, toluene, naphthalene, and other raw materials should be available for export.

7/ Koks i Khimiya, No. 5, May 5, 1959, p. 53.

Germany

Germany has a well-developed chemical industry and uses large quantities of crude coal-chemical materials for manufacturing chemical specialties such as medicinals and pharmaceuticals, cosmetics, synthetic detergents, photochemicals, paints, and synthetic fibers. In addition, Germany exports considerable quantities of benzene, naphthalene, creosote oil, and pitch. The German chemical industry in 1958 utilized only about 35 to 40 percent of its benzene output or about 190 thousand tons out of a total production of 499 thousand tons. One of the major outlets for benzene in Germany is motor fuel. In fact, the use of benzene as a blend in a motor fuel called "arol", which is a mixture of gasoline and benzene, is so extensive that considerable quantities of crude benzene are imported for this purpose. In 1958 Germany imported 80 thousand metric tons of crude benzene from other countries. Although Germany imports benzene for motor-fuel purposes it does not plan to produce benzene from petroleum because it would be difficult to dispose of the resulting gasoline as current gasoline-producing capacity is capable of meeting demand.

Germany consumes about 75 percent of its naphthalene production and exports the rest. Consumption of naphthalene within Germany should increase, as facilities for production of phthalic anhydride are expanding steadily.

The principal uses for the tar oils are as fuel, road material, and wood preservative, and about 20 percent is exported. Pitch, which represents about 58 percent of the tar processed, is used largely for briquetting, road material, pitch coke, and other products. The German briquetting industry consumes about half of the pitch produced; and about 15 percent is exported, mainly to France, where it is also used for briquetting. The remainder of the pitch is used as follows: Road material, 14 percent; pitch coke, 10 percent; heating oils, 1 percent; and miscellaneous other uses, 7 percent. Apparent consumption of light oil and tar products in West Germany in 1957-58 is shown in table 13.

Coke-oven sulfate is not separated from synthetic sulfate in German consumption and export statistics. Germany currently consumes about two-thirds of the chemical fertilizers it produces and exports one-third. Assuming that coke-oven sulfate follows this pattern, about one-third of the production in 1958 (170 thousand tons of coke-oven sulfate) was exported.

United Kingdom

Until the mid-1950's the British chemical industry was not able to absorb all of the benzene produced and it was necessary to market it as motor fuel or export it to other countries. Until 1957, the amount of benzene used as motor fuel was about equal to the output of all other refined products combined (benzene, toluene, xylene, and solvent naphtha). Consumption of benzene as motor fuel ran about 50 million gallons per year. In 1958 production of pure benzene and other refined light-oil products increased substantially because of increased requirements

TABLE 13. - Production, imports, exports, and apparent consumption of principal coal-chemical materials in West Germany, 1957-58, in thousand metric tons

Product	Production		Imports		Exports		Apparent consumption	
	1957	1958	1957	1958	1957	1958	1957	1958
Coal tar	1,956	1,893	24	42	5	------	1,975	1,935
Naphthalene	99	93	3	4	23	30	79	67
Phenol and cresols	33	34	11	8	16	15	28	27
Creosote and other tar derivatives	733	702	4	9	39	40	698	671
Pitch	965	982	35	33	58	109	942	906
Benzene	474	499	69	145	40	4	503	640
Other light-oil derivatives ...	89	70	(1/)	(1/)	(1/)	(1/)	89	70

1/ Included with benzene.

TABLE 14. - Production, imports, exports, and apparent consumption of principal coal-chemical materials in the United Kingdom, 1957-58, in thousand metric tons

Product	Production		Imports		Exports		Apparent consumption	
	1957	1958 1/	1957	1958 1/	1957	1958 1/	1957	1958 1/
Coal tar	2,907	2,640	(2/)	(2/)	91	74	2,816	2,566
Naphthalene	50	53	(2/)	(2/)	8	8	42	45
Creosote oil	445	404	(2/)	(2/)	88	67	357	337
Other tar distillates	89	81	(2/)	(2/)	24	25	65	56
Pitch 3/	2,118	1,920	(2/)	(2/)	236	250	1,882	1,670
Benzene	326	345	(2/)	(2/)	(2/)	(2/)	326	345
Other light-oil derivatives ...	97	103	(2/)	(2/)	(2/)	(2/)	97	103
Ammonium sulfate	345	324	(2/)	(2/)	4/ 209	4/ 310	(5/)	(5/)

1/ Estimated.
2/ None or negligible quantity.
3/ Includes pitch-creosote mixture and road tar.
4/ Includes ammonium sulfate produced from synthetic ammonia.
5/ Apparent consumption of coke-oven sulfate cannot be separated from synthetic materials.

to make synthetic phenol, synthetic fibers, and other end products, and published data indicate that output of pure products is now slightly above motor benzene. Requirements for benzene both as motor fuel and for chemical synthesis in Great Britain have increased and exports have virtually ceased, amounting to only about 70 metric tons in 1957 compared with over 164 thousand metric tons in 1951.

The main requirement for naphthalene in England, as in the United States, is for phthalic anhydride. Another important use for crude naphthalene in England is for fire kindlers. These are shavings and other materials that are saturated with naphthalene and used for igniting fuel in fireplaces. In recent years around 13.5 thousand metric tons per year had been used for this purpose. The pure naphthalene which comprises about one-fourth of the total output of all grades is used in producing dyestuffs, intermediates, and mothballs. Current supplies of naphthalene are greater than domestic requirements, and the surplus is exported. Since 1955 exports of naphthalene averaged about 10 thousand metric tons per year.

Until the beginning of World War II the principal outlets for the bulk products from the tar-distilling industry were road tar, creosote for wood preservation, and pitch for briquetting, and considerable quantities of these products were exported. The use of road tar (which is made by cutting back the "topped" tar or pitch with creosote oil) is widespread and currently accounts for over 600 thousand metric tons annually. A development in the British coal-tar industry during World War II that has provided an outlet for creosote and pitch is the use of creosote pitch as an industrial fuel. Because of shortages of petroleum fuel oils during the war, creosote-pitch mixtures were used as fuel, and experience has shown that these mixtures are, for many purposes, better than petroleum fuels. Therefore the use of creosote-pitch mixtures has continued in open hearth and billet heating, and in heating glassmaking furnaces because they give off a highly emissive flame which permits faster heat transfers than petroleum fuels. About 900 thousand metric tons of this material is consumed each year for this purpose. This development has been of great importance to the stability and welfare of the British tar industry because it has provided an outlet for as much creosote and pitch as the industry cared to allocate. Because this market has the disadvantage of being low-priced, efforts are now being made to increase revenues from tar products by concentrating on producing roofing materials, enamels for cast iron and mild-steel piping, cable sheathing compounds, binders for foundry cores and Soderberg electrodes.

Export markets for British tar products are well established and substantial tonnages of creosote oil, tar acids, and pitch are sold to other countries each year. Since 1955 approximately 40 percent of the creosote and 50 percent of the pitch have been exported. Table 14 shows the apparent consumption of light oil and tar products in the United Kingdom in 1957-58.

France

For many years, output of light-oil products in France, particularly benzene, exceeded requirements of the chemical industry and large quantities were marketed for fuel purposes. The rapid increase in requirements of benzene for producing synthetic organic chemicals in the past several years, however, has reduced the quantities used as fuel. The following data taken from recent foreign service dispatch from the American Embassy in Paris show this shift in use of light-oil products.

Sales of light-oil products, by industries, in thousand metric tons

USES	1955	1956	1957
For fuel purposes	68.0	49.6	28.5
Heavy chemical industry	52.2	56.8	73.2
Other industries	31.4	36.8	43.5
Miscellaneous	0.5	5.1	5.1
Exports	0.3	1.5	18.7
Total	152.4	149.8	169.0

In 1957, France and the Saar together produced 71 thousand metric tons of pure benzene and consumed 68 thousand metric tons. When the Saar becomes economically integrated with Germany after 1960, French production of benzene derived from coal will be below requirements, which are expected to double between 1957 and 1962. Forecasts indicate that production from coal will reach about 100 thousand metric tons but requirements are expected to reach 130 thousand. The French hope to make up this expected deficit from their petrochemical industry.

In France nearly all of the tar is processed, of which about 45 percent is partly distilled or "topped" and the remainder (55 percent) is completely distilled. Principal derivatives are road tar, tar acids, naphthalene, creosote oil, and pitch. The use of road tar as paving material has been rather constant since 1938, running between 300 and 350 thousand metric tons per year and totaled 292 thousand metric tons in 1957. The French briquetting industry currently uses about 550 thousand metric tons of coal-tar pitch, of which about 200 thousand metric tons is supplied by French producers and the balance imported. Traditionally, Great Britain and Germany have supplied 70 to 80 percent of the imports, but since 1953 eastern European countries, particularly the U.S.S.R., have become important sources of supply. The French steel industry also uses tars and pitches for fuel purposes and about 100 thousand metric tons are so used annually. Consumption of creosote for wood preservation is around 45 thousand metric tons annually and about 10 thousand metric tons is used as a wash oil for scrubbing light oil out of the coke-oven gas. About 33 thousand metric tons of pitch in the form of pitch coke are used annually to manufacture carbon electrodes. Table 15 shows apparent consumption of principal coal-chemical materials in France in 1957-58.

Although capacity of French carbonization plants is expected to increase and production of tar will approximate 720 thousand metric tons by 1961, requirements of tar products will be much larger and about 440 thousand metric tons will have to be imported.

Saar

The chemical industry of the Saar has been closely associated with that of France, and most of the Saar's production has been consumed by French markets. Consumption and uses of chemicals in France have already been discussed.

Japan

In spite of substantial increases in production of coal chemicals in Japan in the past several years, requirements have exceeded output, and this country has had to import considerable tonnages. Table 16 shows the apparent consumption of principal coal-chemical materials in Japan for 1957-58. The coal chemicals produced in Japan, as well as the imports, are used to manufacture dyes, plastics, and pharmaceuticals. In fact production of plastics has increased so rapidly that by 1956 this country ranked fourth in the world behind the United States, West Germany, and Great Britain. Of the "coal-tar distillates" imported in 1958, benzene and naphthalene represented almost half of the tonnage. In the period 1955-58, about one-fourth of the naphthalene and one-fifth of the benzene used by the Japanese chemical industry were imported, chiefly from western Europe. To reduce imports of coal chemicals, Japan is planning to increase capacity of petrochemical plants.

Poland

Poland, the seventh ranking country of the world in production of the basic coal chemicals, produces more than its chemical industry can use and each year exports substantial quantities of certain light-oil and tar products. In 1957 about one-fourth of the benzene and only about one-half of the naphthalene output was consumed within the country (table 17). Although Poland uses a higher proportion of its tar products than light-oil products, considerable tonnages of creosote oil and pitch are exported. As in other countries, the principal use of creosote oil in Poland is for treating railroad ties. The major use of pitch is for road construction and binders for briquetting. It has been reported that emphasis will be placed on increasing pitch-coke production for the manufacture of electrodes and published reports indicate that a goal of 45 thousand metric tons of pitch coke by 1960 has been established.

China

Data on consumption of coal chemicals in China are scanty. Requirements of coal chemicals in China have been small and uses of the derivatives from light oil and tar no doubt have not been developed extensively.

TABLE 15. - Production, imports, exports, and apparent consumption of principal coal-chemical materials in France, 1957-58, in thousand metric tons

Product	Production		Imports		Exports		Apparent consumption	
	1957	1958	1957	1958	1957	1958	1957	1958
Coal tar	711	725	49	31	31	51	729	705
Naphthalene	32	34	2	1	7	5	27	30
Creosote oil	158	161	(1)	(1)	25	(1)	133	161
Other tar distillates	32	27	7	43	1	35	38	35
Pitch [2]	530	532	376	403	4	13	902	922
Benzene	96	94	14	1	18	29	92	66
Other light oil distillates	31	30	2	6	(3)	10	33	26
Ammonium sulfate	115	110	(4)	(4)	(4)	(4)	115	110

[1] None or negligible quantity.
[2] Includes road tar.
[3] Included in benzene.
[4] Not available.

TABLE 16. - Production, imports, exports, and apparent consumption of principal coal-chemical materials in Japan, 1957-58, in thousand metric tons

Product	Production		Imports		Exports		Apparent consumption	
	1957	1958	1957	1958	1957	1958	1957	1958
Coal tar	632	600	24	(1)	12	1	644	599
Naphthalene	56	53	11	6	(1)	(1)	67	59
Tar oils	178	162	4	1	(1)	(1)	182	163
Pitch	268	255	(1)	(1)	(1)	(1)	268	255
Benzene	76	71	1	6	(1)	(1)	77	77
Other light oil distillates	20	17	2	4	(1)	(1)	22	21
Ammonium sulfate	128	122	(1)	(1)	60	(2)	68	(2)

[1] None or negligible quantity.
[2] Coke-oven ammonium sulfate not separated from synthetic ammonium sulfate.

TABLE 17. - Production, imports, exports, and apparent consumption of principal coal-chemical materials in Poland, 1956-57, in thousand metric tons

Product	Production		Imports		Exports		Apparent consumption	
	1956	1957	1956	1957	1956	1957	1956	1957
Coal tar	412	430	(1)	(1)	(2)	(2)	412	430
Naphthalene	18	19	(1)	(1)	9	9	9	10
Tar oils	84	105	(1)	(1)	3	4	81	101
Pitch	230	240	(1)	(1)	23	15	207	225
Benzene	106	112	(1)	(1)	100	75	6	37
Other light oil distillates	(3)	(3)	(1)	(1)	(3)	(3)	(3)	(3)

[1] None or negligible quantity.
[2] Not available.
[3] Included with benzene.

Czechoslovakia

Data on consumption and uses of chemicals in Czechoslovakia are lacking. The chemical industry of Czechoslovakia has been unable to utilize all of the benzene and naphthalene produced, and substantial quantities have been exported. In 1957 United States imports of benzene from Czechoslovakia exceeded 4.2 million gallons, which represented about one-fourth of the estimated production in that country. It can be assumed that most of the tar oils and pitch are consumed within the country and used for the same purposes as in other east European countries, namely wood preservatives, road materials, and briquetting binders.

Belgium

In Belgium the organic chemical industry is based primarily on coal, and most of the products recovered through carbonization were used to produce derivatives of ethylene, acetylene, and naphthalene. The most important of these were ethylene oxide, trichloroethylene, butyl alcohol, ethylene glycol, and phthalic anhydride. The organic chemical industry showed the greatest activity in 1957 in producing synthetic detergents, dyestuffs, paints and varnishes, and photographic films and chemicals. The photographic-supplies industry is one of Belgium's most important branches of the chemical industry, and exports amounted to $40 million in 1957.

Italy

The synthetic organic chemical industry of Italy has made remarkable progress in the past several years. Consumption of coal chemicals increased substantially because of increased requirements for the production of dyes, plastics, synthetic fibers, elastomers, pharmaceuticals, and fungacides. Requirements for coal chemicals exceed output in Italy, and considerable quantities are imported. In 1957 the Italian chemical industry used about 27 thousand metric tons of pure benzene of which about half was imported. Consumption of naphthalene amounted to about 24.5 thousand metric tons and imports made up about 70 percent of the total. In addition to benzene and naphthalene, other coal chemicals such as toluene, xylene, phenol, and pitch are imported. The only coal-chemical material exported is ammonium sulfate. As statistics on ammonium sulfate are not separated between synthetic and coke-oven material, consumption and export figures on coke-oven sulfate are not available. However, in recent years approximately one-third of the total ammonium sulfate production was exported. Published reports indicate that exports of sulfate will continue in about the same proportion.

Netherlands

Most of the coal chemicals produced in the Netherlands were refined, but the chemical industries have not yet developed to the

TABLE 18. - United States imports of coal-tar crudes, by countries of origin, 1958, in metric tons 1/

	Coal tar 2/	Creosote oil	Tar oil 3/	Tar acids 4/	Naphthalene	Benzene	Toluene	Xylene
North America:								
Canada	47	....	2,715	65	166	....	2,174	903
Mexico	694	....	....	....	....	....	....	......
Total	741	....	2,715	65	166	....	2,174	903
Europe:								
Belgium	523	16,306	....	7	7,502	....	....	......
Denmark	....	....	....	26	....	....	....	......
France	7	15,600	180	13	770	....	....	......
Germany:								
East	....	....	....	96	....	....	....	......
West	....	22,149	71	609	10,428	5/ 32,802	....	30
Italy	....	....	....	249	....	....	....	......
Netherlands	....	27,679	132	764	1,885	6/ 10,821	....	......
Poland	....	....	62	....	4,893	21,018	....	......
Sweden	....	....	....	28	....	....	....	......
Switzerland	....	....	....	3	....	....	....	(7/)
United Kingdom	2,424	45,166	941	4,115	4,951	....	....	......
U.S.S.R.	....	....	168	....	5,941	82,899	....	......
Total	2,954	126,900	1,554	5,910	36,370	147,540	....	30
Asia: Japan	....	5,075	....	3	....	....	....	......
Africa: Union of South Africa	....	....	....	....	272	....	....	......
Oceania: Australia	....	....	....	25	....	....	....	......
Unspecified	19,308	....	....	....	....	....	....	......
Grand total	23,003	131,975	4,269	6,003	36,808	147,540	2,174	933

1/ Source: Bureau of the Census, U.S. Department of Commerce, Report No. FT 110.
2/ Includes pitch.
3/ Includes anthracene, acenaphthene, pyridine, and other coal-tar distillates.
4/ Includes crude phenol, cresylic acid, cresols, and other coal-tar acids.
5/ Includes transshipments of benzene originating in the Netherlands.
6/ Excludes benzene shipped to the United States via Germany.
7/ Less than 1 ton.

TABLE 19. - United States imports of benzene, creosote, and naphthalene, 1956-58, in thousand metric tons 1/

	Benzene			Creosote			Naphthalene		
	1956	1957	1958	1956	1957	1958	1956	1957	1958
Free countries:									
Belgium-Luxembourg	......	......	......	37.8	32.4	16.3	7.8	8.6	7.5
Canada	1.2	2.0	......	3.6	9.8	......	.1	.1	.2
France	......	......	......	17.6	.6	15.6	2.8	2.4	.8
West Germany	19.1	28.5	2/ 32.8	9.3	19.0	22.1	11.4	13.6	10.4
Japan	......	......	......	9.2	6.1	5.1	......	......	......
Netherlands	9.8	10.8	3/ 10.8	20.7	29.8	27.7	2.7	2.8	1.9
United Kingdom	......	......	......	61.2	28.5	45.1	5.8	5.1	5.0
Other 4/	......	......	......	......	......	......	.4	.2	.3
Total	30.1	41.3	43.6	159.4	126.2	131.9	31.0	32.8	26.1
Communist countries:									
Czechoslovakia	2.6	14.0	......	......	......	......	.1	......	......
East Germany	.9	......	......	......	......	......	......	......	......
Poland	65.3	47.9	21.0	......	......	......	3.7	2.9	4.9
U.S.S.R.	132.2	80.7	82.9	......	......	......	1.0	6.6	5.9
Total	201.0	142.6	103.9	......	......	......	4.8	9.5	10.8
Grand total	231.1	183.9	147.5	159.4	126.2	131.9	35.8	42.3	36.9

1/ Source: Bureau of the Census, U.S. Department of Commerce, Report No. FT 110.
2/ Includes transshipments of benzene originating in the Netherlands.
3/ Does not include benzene produced in Netherlands but shipped to the United States via West Germany.
4/ Finland, Portugal, and Sweden.

TABLE 20. - United States exports of coal tar crudes, by countries of destination, 1958, in metric tons 1/

	Coal tar 2/	Creosote oil	Tar oil 3/	Tar acids 4/	Benzene	Toluene
North America:						
Canada	50,875	1,161	8,931	2,082	23,077	....
Mexico	121	....	1,714	1,020	7	....
Total	50,996	1,161	10,645	3,102	23,084	....
Central and South America:						
Brazil	....	....	1,829	1,024	1,322	....
Chile	14	....	15	1,401	....	....
Venezuela	68	....	1,192	318	133	....
Other Central and South America 5/	534	1,449	609	96	104	....
Total	616	1,449	3,645	2,839	1,559	....
Europe:						
Belgium	11	....	6,210	1,281	....	....
Denmark	....	....	623	301	....	....
France	750	....	492	5,177	9	....
Germany, West	1	....	8,799	1,123	....	....
Italy	512	....	1,991	2,445	12,176	....
Netherlands	....	....	14,132	1,991	....	....
Norway	....	....	1,250	254	....	....
Sweden	10	....	1,414	1,479	....	....
Switzerland	....	(6/)	595	475	....	....
United Kingdom	....	....	48	277	....	....
Other Europe 7/	8	....	18	1,428	19	....
Total	1,292	(6/)	35,572	16,231	12,204	....
Asia:						
India	2	....	232	53	....	....
Israel	66	....	276	627	386	....
Japan	5	....	3,694	2,495	....	....
Korea	5,236	428	9	20	93	....
Taiwan	1,520	....	11	112	10	....
Other Asia 8/	93	(6/)	164	30	623	....
Total	6,922	428	4,386	3,337	1,112	....
Africa:						
Belgian Congo	....	....	81	....	....	....
British East Africa	....	....	86	....	....	....
Union of South Africa	10	....	2,717	113	32	....
Other Africa 9/	19	31	6	10	....	....
Total	29	31	2,890	123	32	....
Oceania:						
Australia	....	11	3,925	4	....	....
French Pacific Islands	....	....	....	....	16	....
New Zealand	....	....	546	3	19	....
Philippines	58	....	143	22	11	....
Total	58	11	4,614	29	46	....
Unspecified	767	....	10	....	....	84,035
Grand total	60,680	3,080	61,762	25,661	38,037	84,035

1/ Source: Bureau of the Census, United States Department of Commerce.
2/ Includes pitch.
3/ Includes anthracene, anthracene oil, carbolic oil, crude light oil, mixtures of benzene-toluene-xylene, solvent naphtha, naphthalene, xylene, ortho xylene, pitch coke, pyridine, tar acid oil, xylene concentrates, and miscellaneous other tar and light oil products.
4/ Includes phenol, carbolic acid, cresols, cresylic acid, and other cyclic acids.
5/ Includes Argentina, Bahama Islands, Bermuda, Bolivia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Guiana (British), Guiana (Dutch), Haiti, Jamaica, Nicaragua, Panama, Paraguay, Peru, Trinidad, and Uruguay.
6/ Less than 1 ton.
7/ Includes Czechoslovakia, Bulgaria, Finland, Greece, Hungary, Poland, Portugal, Spain, and Yugoslavia.
8/ Includes Afghanstan, Malaya (British), Hong Kong, Indonesia, Iran, Lebanon, Pakistan, Saudi Arabia, Singapore, Thailand, Turkey, and Viet Nam.
9/ Includes Angola, Egypt, Morocco (French), Liberia, and Tunisia.

TABLE 21. - West German imports and exports of light-oil and tar products in 1958, in thousand metric tons 1/

	Coal tar 2/	Tar oils 3/	Tar acids 4/	Naphthalene	Pitch 5/	Benzene	Other light-oil distillates
Imports:							
Austria	0.4	1.7	0.3	0.3	1.2	......	....
Belgium	1.2	1.8	.3	....	2.0	......	0.1
Czechoslovakia	6.6	1.3	3.7	.2	4.6	38.4	7.7
Denmark	1.6	......	......	....	......	......	....
France	2.4	1.2	.1	.1	......	.2	1.2
Netherlands	.....	2.7	.1	1.4	2.9	.6	14.1
Poland	.....	.1	......	.3	4.2	27.5	4.0
Saar	35.2	5.9	.1	.4	.1	2.6	.5
United Kingdom	.....	1.1	......	....	2.3	.2	(6/)
United States	.....	.1	.1	....	......	6.7	34.3
U.S.S.R.	.....	......	(6/)	....	16.1	3.9	1.4
Other countries 7/	.6	.2	.4	....	......	......	.5
Unknown	5.4	......	.1	.1	(6/)	(6/)	.2
Total	53.4	16.1	5.2	2.8	33.4	80.1	64.0
Exports:							
Austria	0.1	1.2	0.1	0.2	11.2	......	....
Belgium	.....	.1	.3	2.7	2.5	0.8	(6/)
Denmark	.....	.8	(6/)	.2	......	(6/)	(6/)
France	1.5	.2	1.2	.9	125.9	1.4	0.9
Italy	.....	......	(6/)	3.4	1.3	......	....
Japan	.....	......	(6/)	6.6	......	......	....
Netherlands	.7	2.3	.1	.3	......	.4	.2
Norway	.....	2.7	......	....	1.7	......	....
Saar	.....	.2	......	....	......	......	....
Sweden	.....	.8	.4	....	1.9	......	....
Switzerland	1.1	1.9	.1	.4	5.3	(6/)	.2
United Kingdom	.....	.1	......	.8	......	......	1.8
United States	.....	29.6	.2	12.7	......	2.5	....
Other countries 8/	.5	.3	(6/)	....	10.7	(6/)	1.9
Unknown	.2	.1	.1	.1	.1	.1	.1
Total	4.1	40.3	2.5	28.3	160.6	5.2	5.1

1/ Der Aussenhandel der Bundesrepublik Deutschland, Teil 2, Waren nach Herstellungesländern und Verbrauchsländern, Johrgang 1958, Nr. 12, Verlag W. Kohlhammer GMBH.
2/ Includes other mineral tar.
3/ Creosote and anthracene.
4/ Phenol, cresols, xylenol, and other tar acids.
5/ Includes pitch coke from coal tar and other mineral tar.
6/ Negligible quantity.
7/ Canary Islands, Hungary, and Yugoslavia.
8/ Egypt, Finland, India, French Cameroun, Pakistan, Turkey, and Yugoslavia.

TABLE 22. - Italian imports and exports of light-oil and tar products in 1958, in thousand metric tons 1/

	Coal tar	Tar oils 2/	Naphthalene	Pitch	Benzene	Toluene	Xylene	Other light-oil distillates
Imports:								
Austria	....	......	....	.....	1.8	......	......	....
Czechoslovakia	....	0.8	4.8	.....	3.8	1.6	......	....
France	2.8	.9	....	.....	1.2	......	......	....
Germany	....	.2	3.2	.....	2.5	......	......	4.8
Netherlands	....	1.0	1.5	.....	......	......	......	(3/)
Poland	....	......	2.6	.....	1.4	......	......	....
Rumania	....	......	....	.....	4.1	......	4.6	....
United States	....	1.1	....	.....	7.1	9.5	1.7	10.5
U.S.S.R.	....	......	13.0	.....	5.9	5.6	......	....
Yugoslavia	....	......	....	.....	5.3	......	......	....
Other countries 4/	....	.5	....	.....	.3	......	......	(3/)
Unknown	1.2	.9	8.2	0.1	1.0	.2	......	1.9
Total	4.0	5.4	33.3	.1	34.4	16.9	6.3	17.2
Exports:								
Algeria	....	......	....	3.9	......	......	......	....
France	3.2	......	....	20.7	......	......	......	....
Netherlands	....	......	....	.....	......	......	......	0.4
Switzerland	....	......	....	.....	......	......	......	1.0
Yugoslavia	....	......	....	1.3	......	......	......	.3
Unknown	....	0.6	(3/)	.1	(3/)	(3/)	......	.1
Total	3.2	.6	(3/)	26.0	(3/)	(3/)	......	1.8

1/ Statistica Mensile del Commercio con L'estero, Istituto Centrale di Statistica, Republica Italiana, Dicembre 1958, Roma, Italia.
2/ Includes anthracene.
3/ Negligible quantity.
4/ Belgium-Luxembourg, Switzerland, and the United Kingdom.

TABLE 23. - Japanese imports and exports of light-oil and tar products in 1958, in metric tons 1/

	Coal tar 2/	Tar oils 3/	Tar acids 4/	Naphthalene	Pitch	Benzene	Toluene 5/	Xylene 5/
Imports:								
Canada	.....	......	20	....	.....	....	....	....
China	.....	11	....	1,098	4,769	1,001	....	99
France	.....	......	....	....	.....	....	....	....
Germany, West	.....	217	294	868	.....	(6/)	....	....
Netherlands	.....	......	75	500	.....	....	....	....
Poland	.....	......	....	366	.....	2,499	....	....
Singapore	.....	6,204	....	....	.....	....	....	....
Switzerland	.....	......	....	....	.....	....	....	(6/)
United Kingdom	(6/)	20	240	385	.....	(6/)	....	3
United States	6	2,602	436	3	.....	2,086	1,730	3,021
U.S.S.R.	.....	1	....	3,220	.....	....	....	....
Other countries 7/	.....	......	....	54	.....	....	....	....
Total	6	9,055	1,065	6,494	4,769	5,586	1,730	3,123
Exports:								
Afghanistan	.....	......	....	1	.....	(6/)	(6/)	....
Burma	51	322	....	4	.....	....	....	....
Cambodia	30	......	....	....	.....	....	....	....
Canada	.....	2,007	....	....	.....	....	....	....
Ceylon	.....	293	....	....	.....	....	....	....
China	.....	1	....	....	.....	....	....	....
Formosa	97	2,931	(6/)	25	1	26	2	2
Hong Kong	5	......	....	2	.....	....	....	....
India	.....	(6/)	....	....	.....	(6/)	....	....
Indonesia	.....	......	....	30	.....	....	....	....
Iran	.....	......	....	(6/)	.....	5	....	....
Korea, Republic of	609	2,862	4	6	18	(6/)	1	8
New Hebrides	6	......	....	....	.....	....	....	....
Pakistan	.....	508	(6/)	21	.....	....	....	....
Panama	.....	4	....	....	.....	....	....	....
Philippines	9	2,257	(6/)	1	.....	....	....	....
Ryukyu Islands	47	91	9	19	(6/)	1	(6/)	(6/)
Saudi Arabia	.....	......	....	39	.....	....	....	....
Singapore	.....	15	....	....	.....	....	....	....
United States	.....	4,367	....	3	.....	....	....	....
Central and South America	1	......	(6/)	1	.....	....	....	....
Viet Nam	100	......	....	....	.....	(6/)	....	....
Total	955	15,658	13	152	19	32	3	10

1/ Annual Return of the Foreign Trade of Japan, Ministry of Finance, Japan Tariff Association, Tokyo, Japan, 1958.
2/ Includes mineral tar.
3/ Includes creosote and coal-tar distillates.
4/ Includes phenol and cresols.
5/ Includes solvent naphtha.
6/ Negligible quantity.
7/ Sakhalin and Kuriles.

TABLE 24. - Soviet exports of light-oil and tar products, 1957-58, in thousand metric tons 1/

	Benzene		Toluene		Creosote		Naphthalene		Pitch	
	1957	1958	1957	1958	1957	1958	1957	1958	1957	1958
Free Countries:										
Belgium	......	......	......	......	......	......	......	......	39.4	14.1
France	......	......	......	......	......	......	......	......	129.3	155.2
West Germany	49.1	10.9	......	......	......	......	......	......	......	......
Netherlands	5.2	23.9	......	......	......	......	1.4	......	23.7	22.7
United States	58.4	102.4	......	......	......	......	8.5	7.3	......	......
Other 2/	11.5	6.5	5.6	7.7	13.2	11.5	12.3	19.9	......	5.0
Total	124.2	143.7	5.6	7.7	13.2	11.5	22.2	27.2	192.4	197.0
Communist:										
East Germany	35.6	37.7	4.3	3.6	8.2	10.2	11.8	12.3	......	......
Rumania	3.5	2.5	2.0	3.7	26.1	24.4	.6	.6	......	......
Other 3/	1.5	1.5	1.5	1.8	8.6	12.8	1.5	1.6	4.0	5.4
Total	40.6	41.7	7.8	9.1	42.9	47.4	13.9	14.5	4.0	5.4
Unknown 4/	.1	.1	.5	.7	1.7	1.3	.5	1.8	10.0	5.2
Grand total	164.9	185.5	13.9	17.5	57.8	60.2	36.6	43.5	206.4	207.6

1/ Source: Statistical Review of Foreign Trade of the U.S.S.R. in 1958, Ministry of Foreign Trade of the U.S.S.R., Moscow, 1959.
2/ Canada, Finland, Greece, Iran, Italy, Japan, Spain, Sweden, and Yugoslavia.
3/ Bulgaria and Hungary.
4/ Exports to countries not specified.

point where they can use much of the production. Consequently, about three-fourths of the benzene and 90 percent of the naphthalene production are excess to the country's needs and are exported. Several plants produce a high-grade benzene that is used to manufacture synthetic fibers and plastics. A small amount of naphthalene consumed within the country is converted to phthalic anhydride which is used for synthetic lacquers and varnishes. The chief products of the new petrochemical industry are base materials for synthetic detergents and plasticizers and intermediates for synthetic rubber.

INTERNATIONAL TRADE

Statistics showing origin and destination, by country, of imports and exports of coal chemicals are not available for most of the countries of the world including some of the larger ones. The following compilations were prepared for those countries that publish detailed data on foreign trade. These compilations are not, however, a true measure of the magnitude of the foreign trade of the respective countries, as for example, both the United States and West Germany imported more coal-tar crudes than they exported. These crude materials in many cases are upgraded and used in the production of intermediate and finished chemicals, some of which are exported. Thus, although the United States imports far more benzene and naphthalene than it exports, exports of coal-tar products in 1958, including intermediates, rubber compounding agents, colors, dyes, and stains, were about 68 percent greater than imports of these commodities and had a total value of $101,068,000 compared with a value of $60,167,000 for imports. Another country that imports more coal-tar crudes than it exports is Germany. In 1958, the value of coal-tar crudes imported into Germany totaled $16,635,000 while exports totaled only $12,627,000. However, if all of the products of the German chemical industry are considered, value of exports in 1958 amounted to $856,741,000 against $219,562,000 for value of imports. These figures show that German chemical exports were about four times greater than imports and are indicative of the development of the chemical industry in Germany. Great Britain has a large foreign trade in chemicals and exports were about double the imports totaling $736,771,000 in 1958. However, a breakdown by commodity and country on imports and exports of coal chemicals was not available at the time this report was prepared. Tables 18-20 show the imports and exports of coal-tar crudes for the United States. Imports and exports of light oil and tar products for Germany, Italy, and Japan in 1958 are shown in tables 21-23. Table 24 shows the exports of coal chemicals, by country of destination, for the U.S.S.R. for 1957-58, as no coal-tar crudes were imported in those years.

OUTLOOK FOR COAL CHEMICALS

United States

Production of coal chemicals throughout the world, particularly those from high-temperature carbonization, is governed by blast-furnace operations. This applies especially to the United States, because over 90 percent of the annual production of oven coke is used in blast furnaces to smelt iron ore. Although advancements in blast-furnace technology and improvements in iron ore agglomerating processes will continue to lower the consumption of coke per ton of pig iron in the United States, anticipated expansions in blast-furnace capacity in the next 15 years should increase coke requirements slightly. We can therefore expect the production of coal chemicals to increase slightly above current levels but they will be far short of future requirements of these materials. It is obvious, therefore, that larger proportions of the chemicals required in the future will be supplied by processing natural gas and petroleum. Other processes for producing chemicals from coal may become important in the future.

Considerable research and development work on various low-temperature carbonization processes have been done during the past four decades, but few have prospered economically. Some of these attempts have been successful technically; but the difficulty of finding adequate markets for products, especially for low-temperature tar, a key factor in the economics of low-temperature carbonization, has prevented its commercial realization. Industry and Government are studying low-temperature tar, and it is hoped that new techniques for processing and upgrading this material will be developed that will open up new markets.

Production of coal chemicals by coal hydrogenation is not economically feasible in our country today. Like low-temperature carbonization, the economic success of coal hydrogenation depends on securing enough revenue from the products, for which large markets now exist, to yield an adequate return on the investment. With continuing research, changing economic conditions, and the necessity of providing new raw material sources for chemicals and allied products, the future of coal hydrogenation for this purpose may be changed.

The complete gasification of coal has been studied in this country, and experimental work has been carried on to develop commercial processes for the total conversion of coal into gas by treatment with steam, plus, in most instances, oxygen. The "synthesis gas" so obtained, essentially a mixture of hydrogen and carbon monoxide, may be used for the synthesis of some chemicals or liquid or gaseous fuels. The production of synthesis gas from coal in this country for manufacturing ammonia and methanol has declined because of the availability of relatively cheap natural gas. The production of synthetic liquid and high-heating-value gaseous fuels by this method has been economically unattractive, in view of present petroleum and natural gas prices. As these prices rise, because of decreasing reserves, coal will be used as an important source of synthesis gas to produce these chemicals and fluid fuels.

Foreign Countries

On the international front, virtually every major coke-producing country is vigorously pushing forward with construction and expansion programs in the chemical and allied products fields. In western Europe, construction of facilities to produce synthetic resins and plastics, synthetic fibers, detergents, dyes, pharmaceuticals, and other end products are underway in Great Britain, Germany, France, Belgium, the Netherlands, and Italy. These new facilities will increase requirements for coal chemicals, and greater emphasis will be placed on their production. In all of these countries, however, the greatest activity is in the "petrochemical" sector. In Great Britain, Germany, France, Belgium, and Italy about $549 million was invested in petrochemical facilities by the end of 1957, and investments are expected to reach $1,200 million by the end of 1960. The petrochemical industry of western Europe produced about 831 thousand metric tons of chemicals in terms of carbon content in 1958 and is expected to turn out over 2 million metric tons by 1960. This is more than threefold and indicates that the "petrochemical" industry in western Europe is closely following the pattern established in the United States. If production reaches 2 million tons by the end of 1960, as is anticipated, then requirements for western Europe for petrochemicals will be satisfied by domestic production.

The eastern European countries are likewise expanding facilities for the production of chemical products and are concentrating on increasing production of pure products that will enable them to utilize the chemical raw materials from coke ovens more efficiently in the future. Although precise data are lacking on anticipated expansions of facilities for specific chemical products, information published recently indicates that the Soviet Union is going to place more emphasis on chemicals in the current 7-year plan beginning this year, and heavy capital investments will be made to build facilities to produce plastics, synthetic rubber, and synthetic fibers. The proposed expansion goals of 670 percent for plastics, 400 percent for synthetic fibers, and 340 percent for synthetic rubber facilities are difficult to evaluate because of lack of data on current production of these materials. Information is lacking also on the extent to which the Russian chemical industry will rely on petrochemicals in the future although much of the $17 billion earmarked for the petroleum industry in the 7-year plan ending 1965 will go into petrochemical production.

Poland is also vigorously pushing an expansion and modernization program in her coal-chemical industry so that surpluses of raw materials from coal carbonization can be more efficiently utilized in her chemical industry. The objective in Poland is to upgrade or refine the raw materials so that pure or finished chemicals can be exported instead of the crudes.

In the Far East Japan and China are both engaged in expansion programs in the chemical industry. Japan's chemical industry is developed to a much higher degree than China's, and her chemical requirements are much larger. In recent years Japan has had to import substantial quantities of raw materials for her chemical industry. Japan is relying on her "petrochemical" industry to overcome the present shortages of such chemicals as benzene, phenol, acetone, and ethylene. Although China's chemical industry is still relatively undeveloped and requirements for coal chemicals are small, this country has been increasing coal-carbonizing capacity rapidly in the past several years and can be expected to continue this pace for some years. It is reasonable to assume, therefore, that coal chemical output will increase substantially over the next few years in China.

CONCLUSIONS

Production of organic and inorganic chemicals is climbing rapidly throughout the world, with organic chemicals advancing at a much faster pace, particularly in western Europe, the U.S.S.R., Japan, and possibly China.

Completion of the current expansion programs underway for upgrading or increasing the production of pure products from light oil, tar, and petroleum in France, Italy, Belgium, and Japan should permit these countries to cut back on imports of these commodities. Poland, however, will have more pure and finished chemicals to export in future years if her proposed objectives in this field are attained on schedule. The huge expansion program for the U.S.S.R. chemical industry announced in 1958, which, if carried out, will reduce exports of coal tar crudes after 1965.

In the next decade requirements for chemical raw materials will increase substantially throughout the world. Supplies of coal-tar crudes are expected to rise slowly, however, because improvements in iron-ore and blast-furnace technology will reduce coke rates for iron making, in spite of anticipated increases in steel production. It can be concluded, therefore, that requirements of chemical raw materials will increase faster than they can be supplied from coke ovens and that the petrochemical industry will have to expand to meet the increased demand which the coal-tar industry will be unable to furnish.

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